ENGINEERING PROJECTS (INDIA) LTD.
(A. Govt. of India Enterprise)
PCO-Bhubaneswar

PCO/BBSR/806/159 Dt: 07.03.2024

Sub: Tender for Execution of balance works in CCC building such as civil, sanitary & plumbing works, internal electrical works, ICT works & HVAC works at RourkelaONE project, Rourkela, Sundergarh Dist., Odisha.

Ref: PCO/BBSR/806/159 Dt. 29.02.2024

ADDENDUM NO -I

CONTENTS

SL No.	Technical Specifications
1.	**Technical Specifications -747 Pages**

Note: All other terms and conditions shall remain same as per original scope of work in NIT document.

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The contractor is bound to maintain and deliver the core and shell of the building as per the design intent of the consultants. The final elevation, look and feel of all building shall merge with each other.

1.2.1.3 Construction Documents

The Contractor shall provide multiple options of the design of necessary element of the Work for the Employers Representative to review along with Employer / RSCL and shall proceed further only after its approval and sign off. And related Construction activities shall not commence prior to approval of the same. Any minor modification or alteration to one design shall not be construed as “option of the design”.

The tender drawings shall form the basis for preparation of detailed drawings by the contractor. The Contractor shall get all necessary approvals from the statutory authorities. All development works shall confirm to, shall be designed and constructed / executed in compliance with the applicable statutory regulations and guidelines and comments received from the concerned statutory agencies.

1.2.1.4 Approval Drawings / Documents for Subsequent Approvals

Contractor shall prepare and submit approval drawings, documents, calculations, certificates, etc, and do necessary changes in the drawing if required as may be necessary by the statutory authorities, at the relevant stages. The contractor shall prepare and modify the GFC drawings based on the drawings approved by the statutory authorities.

1.2.1.5 Construction Drawings / Documents Approval Process

Contractor shall submit at least following number of sets for approval of Employer‟s Representative.

A. Construction Documents - 05 sets
B. Samples, datasheets etc - 05 sets

Each of the submission should clearly identify the Work, purpose of the submission, document number etc. as approved in the procedure referred above. Upon review of the said submission Employer‟s Representative shall return the submission with following codes

a. Work may proceed.
b. Revise and Resubmit. Work may proceed subject to resolution of indicated comments.
c. Revise and Resubmit. Work may not proceed.
d. Review not required. Work may proceed.

Although Work may proceed on receipt of a drawing coded 2, Contractor must resolve the comments indicated, resubmit and obtain a Code 1 before release for shipment or completion of the affected Work.

Employer/ Employer‟s Representative review and permission to proceed does not constitute acceptance or approval of submittals including, but not limited to, design details, calculations,

analyses, test methods, construction methods, plans, certificates or materials developed or selected by Contractor and does not relieve Contractor from full compliance with the Contract requirements.

1.2.1.6 Technical Standards and Regulations

Contractor shall refer and implement all relevant and all applicable codes, technical standards, regulations, as amended, required for performance of Work covered under this Contract. Also, all the conditions of statutory approval already taken by the Employer need to be complied during construction stage, the same need to be complied for future approval required if any.

1.2.1.7 Samples

Contractor shall necessarily submit samples of all finishing materials that may affect the look and feel of the project, especially those for which basic rates are indicated in the BOQ and where generic materials are indicated. Submission of samples shall not be limited to the above, and the Employer/ Employer's Representative and Consultant/PMC reserves the right to demand any sample of materials, as deemed necessary.

Where samples are required, they shall be submitted by and at the expense of Contractor allowing at least fourteen (14) calendar days for review by Employer/ Employer's Representative and Consultant/PMC/Architect unless otherwise shown on the Contract Schedule. The materials represented by such samples shall not be manufactured, delivered to the Site or incorporated into the Work without Employer/ Employer's Representative and Consultant/PMC review.

Each sample shall bear a label showing Contractor's name, Work name, Contract number, name of the item, manufacturer's name, brand name, model number, supplier's name, and reference to the appropriate drawing number, technical specification section and paragraph number, all as applicable.

Samples, which have been reviewed, may at Employer's option, are returned to Contractor for incorporation into the Work.

1.2.1.8 MOCK-UP

As deemed necessary by the Employer/Employer‟s Representative/PMC/Architect, Contractor shall execute necessary mock-ups of all items/activities related to the Work performed required under this Contract as indicated below and the cost for the same shall be deemed to be included in the Contract price.

THE FOLLOWING MOCK-UPS SHALL BE EXECUTED BY THE CONTRACTOR:

Item	Extent / Size
1. Facade / Glazing systems	Height - One floor Width - 03 modules [including one operable module, if any]
2. GRC Jail	1.0 x 1.0 M
3. Stone cladding, Paint, brick jali including window glazing, aluminium louvers, flashings and interface details	6.0 x 6.0 M
4. All finishing items including but not limited to toilets, flooring, wall cladding, doors & windows, false ceiling, etc.	Toilets - 01 module including all fittings, fixtures and modular partitions Hard & soft finishes - approx 50 sqft, including all typical interfaces and details.
5. Railings and other metal fabrication works	Min 2.0 RM including all types of details [turns, bends, ends, etc]
6. Pergola	3.0 x 3.0 M including all interface details
7. Polycarbonate Skylights	3.0 x 3.0 M including all interface details

1.2.1.9 Documents At Site

The contractor shall maintain in a conspicuous place on the site a copy of development permission and a copy of approved drawings and specifications.

1.2.1.10 AS-BUILT DRAWINGS.

Progress As-Builts / GFC drawings

During construction, Contractor shall keep a marked-up-to-date set of progress as-built / GFC drawings and specifications on the Site as an accurate record of all deviations between Work as shown and Work as installed. These drawings and specifications shall be available to Employer for inspection at any time during regular business hours.

Final As-Builts.

A. Contractor shall at his expense and not later than thirty (30) calendar days from Taking over Certificates and before Final Payment furnish to Employer a complete set of marked-up as-built reproducible drawings and specifications with “AS-BUILT” clearly printed on each sheet and on the specification cover.

B. Contractor shall accurately and neatly transfer all deviations from progress as-built to final as built drawings and all annotations from progress as-built to final as-built specifications.

C. Contractor will provide four (4) copies of the as-built drawings of which one (1) is in fully editable electronic format in a form acceptable to the Employer. Employer shall provide editable electronic copy of the requisite drawings such as floor plans, to facilitate preparation of electronic as-built-drawing.

Endorsement.

A. Contractor shall sign each final as-built drawing and the cover of the as-built specifications and shall note thereon that the recording of deviations and annotations is complete and accurate.

1.2.1.11 Specifications

The specifications forming part of this Contract have been drawn up with all possible care and are intended to cover the supply of all the materials, tools, plants and equipment, labour and the execution of all works necessary to complete the entire Work in all respects under this Contract. In case there are any details of construction or materials which have not been referred to in the specifications, detailed descriptions of items, schedule quantities, or the drawings but which are usual or essential in the true completion of the purpose of the Work, the same shall be deemed to have been included in the price quoted by the contractor. Wherever specifications are not stipulated, the Work shall be as per latest ISI specifications and/or directed by the Employer/ Employer"s Representative and Consultant/RSCL following good Engineering practice.

1.2.2 Civil

The Scope of Work under this contract includes but is not limited to the following in relation to the design, construction, and operation of the Works:

- Contractor shall prepare and submit Design Basis Report for approval based on the design Intent.
- Site Topographic Survey and Geotechnical Investigations as deemed necessary by the Contractor as per BIS latest codes, NBC etc as applicable through any nationally accredited lab. Employer may verify the results submitted by contractor, if need be.
- Construction enabling works like site office, labour camp, material stacking, laboratory, etc. shall be the responsibility of contractor.
- Setting out of the works.
- Site Clearing, Site Grading, and Excavation, disposal of excavated earth and bailing out & disposal of water.
- Contractor shall do Structural Design based on approved Civil Structural Design Criteria.
- Preparation of complete structural design, drawings for foundation, basements, podiums, superstructure and for other related structures in the housing pocket. i. e. UGRs, pump house,

DG set meter room, substation building, gate, compound wall, chambers, trenches etc to be provided as per provision contained in IS codes/NBC but not lower than the minimum criteria mentioned in the tender., Scales for each detail in drawing and drawing sheets shall be use as per BIS standards.

- Contractor shall submit Structural stability certificate for 10 years and life span building structure certificate for 50 years for all structures and components to Rourkela smart city corporation with his own cost.
- Construction of all Civil Structures and Building finishes Work of all structures in housing pocket.
- For all structural designs and drawings, the contractor must get the proof check done by accredited agencies at his own cost before submitting for the approval of the client.
- One Copy of structural design calculations and details in soft and hard copy (latest version of software) based on the approved building plan shall be submitted before commencement of the construction work at site for information and record.
- Submission of Detailed Engineering Designs, Drawings, Process Calculations, Data Sheets for approval.
- Execution of all Civil Works at Site including Construction, Erection, Testing and Handing over.
- Design and Construction of Internal Roads, Curbs, Pavements, Parking Spaces, Compound Wall, water supply and sewage disposal and Storm Water Drains etc.
- Water tanks shall be designed for limited crack width as per BIS code and checked for water tightness after construction.
- Implementing Anti-termite treatment / Water proofing / Insulation works. Contractor shall submit warranty certificate for same in approved format.
- Plantation and Landscaping works.
- Preparation and Submission of As-Built drawings for Civil and Structural Works.
- Issuing Warranty certificate for Anti-termite treatment / Water proofing / Insulation works.
- Maintaining safety requirements and relevant Government Regulations and ensure their implementation.
- Safety reporting: Brief reports of all accidents and hazardous incidents including descriptions of causes, extent of injuries, action taken, and precautions instituted to prevent repetition of such events.

Guarantee for construction defect/manufacturing defects during defect liability period: Contractor shall guarantee the entire work for period of minimum 36 months after completion of work. Any damage or defect that may arise or that may remain undiscovered at the time of issue of completion certificate connected in any way with the equipment or materials supplied by him or in the workmanship be rectified or replaced by contractor at his own expense as desired by engineer-in-charge or in default may cause the same to be made good by other agency and deduct expenses there of (for which the certificate of engineer-in-charge shall be final) from any sums that may then or any time thereafter become due to contractor or of sale thereof or a sufficient portion thereof. The contractors shall be liable to construction defect/ manufacturing defects and not liable to damage caused by occupants if any.

The Contractor shall institute a Quality Assurance and Quality Control (QA/QC) system in accordance with the requirements to demonstrate compliance with the requirements of the Contract. The

Contractor shall submit, within 14 days of signing of the Contract Agreement, the required Quality Assurance and Quality Control (QA/QC) Program for approval by the Employer's Representative. The Employer's Representative will either approve the submittal or provide comments thereon to the Contractor within 14 days of submission by the Contractor. The Employer's Representative's, approval, disapproval, comments, or failure to provide any of these to the Contractor, shall in no way relieve the Contractor of any of its obligations or responsibilities under the Contract. The Contractor, prior to commencement of work at the Site, shall set up his own laboratory, with prior notification to the Employer's Representative. The calibration of the laboratory equipment and instruments shall be certified by agencies approved by the Employer's Representative. Laboratory equipment shall be properly maintained and calibrated throughout the period of the Contract by the Contractor at his own expense. The Contractor shall give the Employer's Representative reasonable advance notice prior to conducting any tests required by the Bid Documents, which the Employer's Representative may choose to witness at his discretion. The Employer's Representative will also inspect the laboratory if deemed necessary and the Contractor shall provide adequate facilities to the Employer's Representative that may be necessary for witnessing testing or for independent verification of the accuracy and adequacy of the facilities and equipment. Compliance with the QA/QC system shall not relieve the Contractor of any of his duties, obligations, or responsibilities under the Contract. Contractor shall maintain Quality Control records. QA/QC records till the completion of Defect liability Period shall be maintained.

Weekly/Fortnightly/Monthly Progress Reports, along with photographs depicting the progress achieved in the month, shall be prepared by the Contractor in a format approved by the Employer's Representative and the Employer and submitted to the Employer's Representative. Contractor shall submit Weekly/Fortnightly/Monthly Progress Reports in review meetings for Project Progress and approval.

1.2.3 ELECTRICAL

1.2.3.1 The scope consists of design, engineering and manufacturing; testing at Manufacturer's works, packing, forwarding and delivery to site; unloading and handling at site (shifting from unloading point to the storage area, storage and shifting from the place of storage to the place of installation), assembly, erection, cleaning & touch up painting; testing & commissioning at site for **Command & Control Centre, Auditorium, Convention Hall, Tribal Museum and Open Air Theatre** at rOURkela One in Rourkela.

1.2.3.2 Following shall be considered for the Electrical Works:

(a) Four pole structure for terminating incoming 33kV overhead lines.

(b) Metering equipments as per OERC Net Metering regulation – one each for the different buildings in the respective RMUs.

(c) Outdoor type 33kV Metered RMUs with FRTU with self-healing feature

(d) 33 kV Cable, DWC HDPE Pipes with Manholes in Ring Distribution System

(e) 33kV Compact substation having VCB, Dry Type Transformer & LT breaker.

(f) Diesel Generator set with AMF Panel.

(g) Aluminium sandwiched type bus duct

(h) 3 Phase, 415 V, 50 Hz LT Power Control Centre (PCC) panel.

(i) 3 Phase, 415 Volts, 50 Hz, Automatic Power Factor Control (APFC) Panel and Hybrid Power Factor Control (HPFC) Panel.

(j) LT cables and associated cable laying and interconnection system, GI cable trays and GI raceways etc.

(k) Sub panels / Floor Panels, Power Distribution Board (PDB), Lighting Distribution Board (LDB) and Emergency UPSDB

(l) Recessed point wiring for fan, light, power receptacle, exhaust fan, etc

(m) Earthing System.

(n) Lightning Protection System

(o) Indoor and Outdoor Lighting Work including decorative lighting fixtures power receptacle, occupancy-based sensor, and decorative poles.

(p) Passenger Elevators

(q) UPS system with Lead Acid SMF batteries for emergency lighting backup, computers, and UPS DBs

(r) Charging points/ facilities for low-emitting vehicles within the site to cater at least 5% of total parking capacity will also be provided to comply with IGBC regulations.

(s) Illumination system with smart features for Street Lights, area lighting for Parking zones, Gardens with outdoor type feeder pillars at strategic locations, adequate Sockets for Grass cutting machines, post top lanterns, Bollards, street lights, flood lights, high mast lights, step lights, Spot lights, uplighters.

(t) Earthing and lightning protection system for the Outdoor equipments, Street Light and Poles.

(u) Liasioning with WESCO, CEIG and any other statutory regulatory body as relevant for getting complete approval of Electrical installation works.

(v) Relay Co-ordination for entire Electrical system under scope as specified above with reference to upstream and downstream distribution systems.

(w) Solar roof top system on Net Metering model on the identified shadow free area after construction of the buildings in a separate tender

(x) Miscellaneous statutory equipment needed for completion of work.

1.2.3.3 This specification is the minimum requirement and should be read in conjunction with relevant latest IS/IEC/DISCOM/OERC specifications, requirements, rules and regulations. The bidder shall refer the most stringent specification. Any additional requirements shall be offered by BIDDER as per DISCOM/OERC specifications, requirements, rules and regulations.

1.2.3.4 Equipments furnished shall be complete in every respect with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the DPR unless included in the list of exclusions.

1.2.3.5 The Contractor shall carry out measurement of soil resistivity at site by Wenner's four electrode method as per IS: 3043 – 1987 and its latest amendments, at minimum two (2) locations. The soil resistivity at site by Wenner's four electrode method as per IS: 3043 – 1987 and its latest amendments, at minimum two (2) locations shall be carried out by the Contractor. The measurements shall be carried in the presence of the EMPLOYER and the results/ report shall be certified by Govt. Authorised Labs or agencies.

1.2.3.6 Necessary statutory approvals, new connection from WESCO for the electrical systems installed shall also be in the Contractor's scope.

1.2.3.7 All mounting and foundation supports and hardware accessories for electrical equipment/system installations.

1.2.3.8 All civil works associated with equipment/system electrical installations like embedment, chipping, punching, making holes, openings in walls, pipe sleeves, fire/ water proof sealing etc.

1.2.3.9 The CONTRACTOR shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The design of various components, assemblies and sub-assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.2.3.10 Equipments furnished shall be complete in all respects with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as indicated in applicable codes, though they may not have been specifically detailed in the Technical Specification, unless included in the list of exclusions. Materials and component not specifically stated in the specification but which are necessary for commissioning and satisfactory operation unless specifically excluded shall be deemed to be included in the scope of specification and shall be supplied without any extra cost. All similar standard components/ parts of similar standard equipment provided shall be inter-changeable with one another.

1.2.3.11 All SAFETY considerations in design, manufacturing and installation of equipments and systems for safe operation & maintenance by EMPLOYER personnel and safe practices during installation at site shall be in the scope of the Contractor. Cost towards accomplishing the same shall be included in the BID price and no extra claim shall be entertained later.

1.2.3.12 Battery Limits

i. **Command and Control Centre**: The following shall be the excluded from the scope of rOURkela ONE bidder:

- BMS, EMS, UPS for Server, Computers, lighting, power & computer sockets, conduiting, wiring, control panel, floor panel, earthing, recessed point wiring, sub wiring, DB, LT cables and associated cable laying and interconnection system, cable trays and raceways and associated works complete in all respects of 3 floors (2^{nd}, 3^{rd} and 4^{th}).
- rOURkela ONE bidder shall interface with MSI Contractor, appointed by the RSCL, for the power supply requirement for their working. A sub-meter for metering the energy consumption shall be provided.
- rOURkela ONE bidder shall provide two LT feeders from PCC of CCC building to electrical room at one point only. Each LT feeder will be designed for 100% load to maintain redundancy. Further power distribution shall be in the scope of MSI Bidder.

The CONTRACTOR shall ensure coordination with the MSI, to be appointed by RSCL separately, ensuring completion of work.

ii. **Tribal Museum**: The interiors of the Tribal Museum is being proposed to be executed in a separate tender. Hence, necessary conduiting, raceways, wiring, cabling, etc for providing power to museum specific requirement shall not be in this tender scope.

The Tribal museum shall be provisioned with power receptacles and normal indoor lighting. The tapping of power for museum specific requirements shall be in the museum vendor's scope with necessary electrical and civil works. Necessary coordination with Museum vendor shall be in Bidder Scope.

1.2.3.13 General System Requirements

i. The proposed Electrical Power Distribution and Lighting System shall be designed to provide:

a) Electrical supply to equipment and machinery within the design operating limits.

b) Safety to Personnel and equipment during both operation and maintenance.

c) Reliability & Continuity of Service.

d) Minimal fire risk with fail safe feature.

e) Ease & flexibility of maintenance and operation.

f) Adequate provision for future expansion and modification.

g) Maximum inter-changeability of equipment.

h) Energy efficient equipment/ system with BEE (Bureau of Energy Efficiency) Rating above 3 stars.

i) Suitability for applicable environmental factors.

j) Service Condition

ii. All the components of the electrical system shall be sized to suit the maximum load under the most severe operating conditions. Accordingly, the maximum simultaneous consumption of power, required by continuously operating loads shall be considered and an additional margin

shall be taken into account for intermittent service loads, if any. The amount of electrical power consumed by each area shall be calculated for its operation at the design capacity.

iii. The equipment shall be designed and manufactured in accordance with the best engineering practices and shall be suitable for the intended purpose.

1.2.3.14 List of Submissions

i. Equipment/ system Detail Engineering Drawings, Data sheets, sizing Calculations etc shall be submitted for review and approval by EMPLOYER before execution/ procurement and manufacturing; Test reports, commissioning reports and performance reports of all electrical system/ equipment shall also be submitted for review & acceptance by EMPLOYER.

ii. Submission of Type test reports carried out at accredited laboratories like ERDA, CPRI or equivalent as per requirements of state DISCOM.

iii. Submission of all "As Built" drawings, Data sheets, Calculations etc. after execution and commissioning of the equipment and systems above.

iv. Submission of relevant documents and drawings to the concerned statutory authorities/ agencies and getting clearance and approval for the supplied and installed equipment under this specification is solely the responsibility of the CONTRACTOR.

v. All coordination for Liaison and obtaining required mandatory approvals/ NOCs from Electrical Inspector and any other Statutory Authority as applicable for drawings & documents, initiation of works, load release, charging and commissioning of entire power distribution system within the scope of this Document.

1.2.3.15 Applicable Code and Standards

i. The design, material, construction, manufacture, inspection, installation, testing and performance of electrical equipments & systems should conform to the latest applicable Central Electrical Authority (CEA) guidelines, all currently applicable IS, IEC and IEEE standards, Central PWD (CPWD) Specifications, Odisha PWD Specifications, National Building Code, National and International codes of practice, statutes, regulations and safety codes in the locality where the equipment will be installed.

ii. All codes and standards referred to in this specification shall be understood to be the latest version on the date of offer made by the Bidder unless otherwise indicated.

1.2.3.16 System Design Parameters

i. The electrical system shall be designed as per relevant standards and local regulations with the stringent of the two regulations being the governing parameter.

ii. Following System Parameter shall be adopted for designing the electrical system:

Nominal (Rated) System Voltage	33kV	0.415kV
Highest System Voltage	36kV	1.1kV
Lightning Impulse Withstand Voltage (1.2/ 50 microsecond)	170 kVp	-
Power Frequency Withstand Voltage for 1 minute	70 kV rms	3 kV rms
System Neutral Earthing	Solidly Earthed	Solidly Earthed
Fault Level of System	25kA for 1sec.	Contractor to calculate
Frequency	50 Hz	50 Hz
Dynamic Short Circuit Current Rating	62.5 kA peak	As calculated

iii. Service Condition:

- Design Ambient Temperature – 50 ºC.
- Relative Humidity – Maximum - 90%; Minimum – 10%.

1.2.3.17 Quality control plan

i. The Quality Control Plan shall list and define in sequential order all process control activities, inspection and tests proposed on the equipment / material starting from component procurement and from testing stages to product dispatch. The Quality Control Plan shall indicate and identify the applicable standards, detailed description with diagram, the procedure, acceptance criteria, extend of check and record to be generated.

1.2.3.18 Inspection

i. PURCHASER may inspect all the supply components/ equipments/ systems at Vendor's work. All type test certificates of the bought out items and internal test certificates shall be furnished at the time of inspection.

ii. Type/ Routine tests according to relevant standards shall be performed in the presence of PURCHASER representative if agreed.

iii. All necessary measuring and testing equipments shall be arranged by the VENDOR or its Sub-VENDOR at the time of inspection as well as during commissioning at site without any cost

implication to the PURCHASER. All such instruments shall be calibrated from Authorized agencies not older than a year from the date of inspection.

1.2.3.19 System / Equipment Design Criteria:

i. The system shall be designed taking in to consideration the following system variation:
- Voltage: +10% to -10%
- Frequency: +3% to -3%
- Combined voltage and frequency variation: +10% to -10%

ii. The load distribution should be such that the load unbalances does not exceed 5% at the point of commencement of supply as per OERC regulation.

iii. The system power factor shall be at least greater than 0.98

iv. In normal operating condition, cumulative voltage drop from PCC to the last equipment in the topmost floor shall not exceed 6% (measured at load end).

v. Voltage dip at the Motor terminals during motor starting of the highest rating motor with regular base load shall not exceed 15%.

vi. Fault level for HT shall be considered as 25kA for 1 sec or actual calculated during detailed design stage by the contractor, the stringent being applicable.

vii. The fault level for LT system at transformer terminal shall be calculated based on the transformer rating and its impedance as per relevant IS 2026 / 11171. The transformer losses shall be limited as per ECBC guidelines. However, minimum short circuit rating of switchgear and cable withstanding capacity shall be considered as 35kA for 1 sec for MCCB, 50kA for 1 sec for ACB switchgear and Busbar Short Circuit as per SLD or actual calculation.

viii. For Lighting, Air conditioning and other Miscellaneous Power outlets following shall be the parameters to be considered:

Nominal Voltage	240V
Phases	1
Frequency	50Hz
Connection	3 wires(Phase, Neutral & Earth)

1.2.3.20 Estimation of Load/ Max Demand

i. The following considerations are to be followed to arrive at the maximum electrical demand.

a) Load Factor: As per Manufacture's Data

b) Power factor of Motors: As per the Manufacture's Data sheets

c) Efficiency of IE2 motors: As per the Manufacturer's Data sheets

d) Overall diversity factor shall be considered for the buildings depending on the services proposed.

e) Minimum starting current for various types of starter applications shall be considered as following:

- DOL Starter – 6 times the rated current.
- Star- Delta Starter – 3 times the rated current.
- Auto Transformer Starter (ATS) – 3 times the rated current.
- Soft Starter – 3 times the rated current.

1.2.3.21 Electrical Power Supply

As per OERC regulation, the incoming supply voltage shall be decided.

1.2.3.22 Power Distribution Philosophy

i. The power supply to the plot shall be provided from the nearest 33 kV overhead line being fed from 132/33kV Rourkela Grid Sub-station. A 4pole structure shall be provisioned in the site as per location designated in the drawing TCE.10839A-EL-4002-GA-40033. The four-pole structure shall be as per WESCO specifications with provisioning of GOD, DO Fuse, Lightning Arrestor. In case there be need for any 33kV conductor upgradation the same shall be in Contractors' scope as per direction of Executive Engineer, WESCO.

ii. The power distribution inside rOURkela ONE development till each building shall be through 33 kV underground cables in ring main distribution configuration. All the buildings will be fed in ring networks for better reliability & 33kV ring will be designed for maximum load of 10MVA. After Operation and Maintenance period, this ring network shall be handed over to WESCO for further Operation and Maintenance.

iii. Tariff metering arrangement shall be as per DISCOM (WESCO) standards & specifications for each building.

iv. **Command and Control Centre Building**-Two numbers of Compact Substations (CSS) are proposed to step down the HV voltage to LV voltage for further usage. CSS shall be 100%

redundant to each other. There shall be 2 numbers of Diesel Generator set with a synchronising panel. Refer TCE.10839A-EL-4002-AU-40032 for the distribution schematic. The distribution configuration for the CSS is proposed to be 2x50% configuration, with the transformers capable of catering 100% load requirement. The CSS incomers shall terminate at different bus sections. 100% DG back up with 2 numbers of equal rating Diesel Generator sets with synchronising panel have been provisioned. Hybrid Power Factor Correction (HPFC) panels is proposed to ensure improved power factor up to 0.98 and reduced harmonics distortion. The HPFC panels should be provided at each bus sections.

Further distribution from the PCC panel shall be through floor panels, feeder pillars, HVAC panel, Fire Fighting Panel, Pluming panel, Elevator panel, UPS panel. MSI Floor panels and UPS panel shall be provided with 2 feeders from the different bus sections of the PCC to ensure redundancy. From the Floor panels, power shall be distributed to lighting and power loads through Lighting Distribution Boards and Power Distribution Boards.

2 x 100% modular redundant UPS system with Static by-pass and 2 x 100% Lead Acid SMF VRLA battery bank with 30 mins back up shall be provided for providing power supply to critical loads and emergency lighting through Output UPS Distribution Board. The UPS should have Predictive failure notification, input phase sequence corrector features. The UPS DB shall cater to emergency Lighting and Critical power loads through UPS Sub-Distribution panel at the respective floors.

v. **Auditorium and Convention Centre Building**- A Compact Substation (CSS) has been proposed to step down the HV voltage to LV voltage for further distribution and usage. 100% power back up by 1 No of Diesel Generator set with an AMF panel is proposed. Refer TCE.10839A-EL-4002-AU-40031 for the distribution schematic. The transformer and DG set outgoings shall be terminated on the PCC bus. LV capacitor banks with control panel consisting of automatic power factor correction (APFC) relay to improve the plant power factor up to 0.98 shall be provided and connected at the PCC for each of the buildings.

Further distribution of power to each area shall be carried out through dedicated sub panel for each floor for lighting & receptacles, HVAC, Fire Fighting, Elevator, Plumbing, ICT and other loads. From the Floor panels, power shall be distributed to lighting and power loads through Lighting Distribution Boards and Power Distribution Boards.

Conventional non-redundant UPS system with 100% Lead Acid SMF VRLA battery with 30 mins back up shall be provided for the Emergency lighting through Output UPS Distribution Board.

vi. **Tribal Museum**- A Compact Substation (CSS) has been proposed to step down the HV voltage to LV voltage for further usage. 100% power back up by 1 No of Diesel Generator set with an AMF panel is proposed. Refer TCE.10839A-EL-4002-AU-40033 for the distribution schematic. The transformer and DG set outgoings shall be terminated on the PCC bus. LV

capacitor banks with control panel consisting of automatic power factor correction (APFC) relay to improve the plant power factor up to 0.98 shall be provided and connected at the PCC for each of the buildings.

Further distribution of power to each area shall be carried out through dedicated sub panel for each floor for lighting & receptacles, HVAC, Fire Fighting, Elevator, Plumbing, ICT and other loads. From the Floor panels, power shall be distributed to lighting and power loads through Lighting Distribution Boards and Power Distribution Boards. STP for the plot shall be provided power supply from the PCC with sub-metering using tariff meter as per WESCO specifications. Conventional non-redundant UPS system with 100% Lead Acid SMF VRLA battery with 15 mins back up shall be provided for the Emergency lighting through Output UPS Distribution Board.

vii. **Open air theatre**- A 33kV RMU shall be provisioned near the proposed area which shall be utilized to tap power for future development. Presently, power for the open-air theatre is proposed to be provisioned form the tribal museum PCC panel. Outdoor Feeder Pillars will be supplied from the Tribal Museum PCC, which will further distribute power to the lighting fixtures and power receptacles provisioned in the open-air theatre.

viii. **For the entire project site**, All DG sets shall be provided with all the required accessories and auxiliary systems like acoustic enclosure, silencer, metal stack (as per Pollution Control Board Regulations), breaker and protection panel with provision for incoming and outgoing cable connections, fuel day tank, foundation, earthing and other utility piping.

For all buildings, Normal Lighting for each floor shall be provided through separate per Phase isolated three phase Distribution Boards for each floor fed from the floor sub-panel located at respective floor Electrical Room. Emergency Lighting for each floor shall be provided through separate per phase isolated three phase Distribution Boards for each floor fed from the UPS Main DB located at Electrical Room.

Single phase power for General Purpose as well as Dedicated Power Outlets shall be provided through separate Raw Power DBs located in each floor fed from PCC at Electrical Room. All the cabling from the PCC to the individual floors shall be laid on cable trays through a dedicated RCC Duct of adequate size with access window on each floor. The duct shall be suitably located near the area where the DBs are located.

1.2.3.23 33kV RMU (Ring Main Unit)

In order to feed HT Distribution plots, 3 /4 way gas based Outdoor RMU having 2 load break Isolators and one/two number of outgoing VCB with 24V DC system with battery and charger and FPI (Fault passage indicator) will be located near to individual consumer plots of rOURkela ONE. All RMU's will be interconnected and finally the total loop of RMU's will emanate and terminate at 33kV 4 pole structure located near to Plot Boundary. FRTU (Field terminal unit) with self-healing feature shall be considered for remote operation of RMU. These RMUs shall have metering provision for housing HT meters for each individual plot. These meters shall be as per OERC / WESCO specifications.

1.2.3.24 Compact Substation (CSS)

i. **For Command Control Centre,** the Compact Sub-Station (CSS) shall comprise of 1 No of 33kV 630A Vacuum Circuit Breaker, 1 No of 1250kVA Dry type distribution transformer and a 2000A EDO type ACB accommodated in HT, Transformer and LT compartments respectively. N-1 distribution scheme will be provided for redundancy to feed CCC LT load.

ii. **For Auditorium and Convention Centre,** the Compact Sub-Station (CSS) shall comprise of 1 No of 33kV 630A Vacuum Circuit Breaker, 1 No of 800kVA Dry type distribution transformer and a 1600A 4P ACB, EDO type accommodated in HT, Transformer and LT compartments respectively.

iii. **For Tribal Museum,** the Compact Sub-Station (CSS) shall comprise of 1 No of 33kV 630A Vacuum Circuit Breaker, 1 No of 500kVA Dry type distribution transformer and 800A EDO type ACB accommodated in HT, Transformer and LT compartments respectively.

iv. As per CEA regulations, if the length of cable exceeds 15m from point of supply to the consumer breaker then a point of supply isolation shall be provisioned.

1.2.3.25 33/0.433kV Dry Type Transformer

i. 33/0.433kV transformer shall be Dry type with Off-circuit tap changer (OCTC) with tap changing ranging from +5% to -10% in steps 2.5% complying with IS 11171, ECBC and other relevant standards as amended till date. The transformer losses shall be as per ECBC 2017 requirement.

ii. The transformer shall be sized taking into the following consideration:

(a) Connected loads
(b) Load factor, Diversity factor as indicated above
(c) 10% contingency factor over cumulative maximum demand
(d) 80% loading of the transformer
(e) Voltage dip at the largest motor terminal during its starting on base load condition. The voltage dip shall be less than 15% taking into consideration motor starting method.
(f) Power factor improvement to 0.95

1.2.3.26 Emergency Power Supply – Diesel Generator (DG) Set

i. The capacity of the DG shall be calculated based on the total simultaneous maximum demand of all the loads (calculated based on the load factors, PF, efficiency and diversity indicated above). A contingency factor of 10% over the cumulative maximum demand (MD) shall be considered. The size of the selected DG set shall be calculated such that the maximum loading shall not exceed 80% at 0.8 power factor.

ii. The adequacy of DG sizing shall also be checked on the basis of voltage dip at the motor terminal during the starting of the largest motor considering base loading condition, i.e., all other loads except the highest rated motor. The voltage dip at motor terminal shall not exceed 15% taking into consideration the use of appropriate starter.

iii. The step loading of the engine of the DG shall not exceed 40% of the maximum load catering capacity, i.e., 80% of rated capacity.

iv. 100% emergency backup shall be provided for CCC with 2 Nos. of DG set with Synchronising panel. The arrangement shall ensure optimum utilisation of the DG sets with reduced fuel consumption as the synchronising panel shall operate one DG set on sensing failure of incoming mains. When the load on the DG set exceeds 80% of rated capacity, another DG set shall be switched on and synched with load sharing. As the loads on DG decreases, the synchronising panel shall turn of one of the DG first such that the working one is loaded less

than 80% of rated capacity. This mechanism shall ensure efficient working of DG sets and optimum fuel consumption.

v. 100% emergency backup shall be considered for Auditorium building with 1 No. of DG set with AMF panel.

vi. The DG set shall have acoustic enclosure ensuring the noise level shall be 75dB (A) at 1m from enclosure, as per relevant state pollution control board regulation. The enclosure shall provide IP55 protection to the DG set.

vii. DG Exhaust Height calculation: As per NBC / CPWD guidelines, the height of exhaust stack shall be calculated and provisioned.

1.2.3.27 Fault Level

i. Fault level at transformer secondary and at 415V LT panels shall be calculated based on the transformer rating and impedances of transformer and cables. In case of large motors, the same shall be considered.

1.2.3.28 Power Factor Improvement

i. The required capacitor rating shall be calculated based on the system power factor requirement of achieving 0.98 power factor, i.e., 0.81 or actual (whichever is lesser) to be corrected for 0.98.

ii. The capacitor sizing for the HPFC and APFC Panel shall be selected considering following design criteria:

(a) Optimum no of steps to ensure proper regulation with minimum two (2) nos. of spare steps subject to a maximum of 12 steps

(b) Minimum steps of 5 kVAR and 10 kVAR bank in adequate nos. for fine regulation of power factor at low loads shall be considered. Balance capacity can be considered with 25 kVAR, 50 kVAR or 100kVAR capacitor bank.

(c) Capacitor banks shall be All Poly Propylene (APP), double layer type.

(d) Adequate no-load compensation for the transformer at the CSS.

iii. HPFC panel shall be provided with adequate size active harmonic filters (AHF) to ensure total harmonics distortion (Voltage) is within the limits specified in IEEE Std 519 (latest). The harmonic filtering equipment shall also be able to correct either leading (capacitive) or lagging (reactive) power factors as well. The AHF shall also have the ability to correct displacement power factor (DPF) and mains current balancing. DPF correction can be provided for either leading (capacitive) or lagging (inductive) loads that cause poor DPF.

iv. Command and Control Centre shall be provided with HPFC panels whereas other buildings shall be provided with APFC panels.

1.2.3.29 Sandwich LT Bus Duct

i. If the full load current of an incomer increases beyond 1000A, using cables for interconnection shall not be a viable option and bus duct shall be recommended. The connection from CSS / DG Synchronizing Panel / DG AMF Panel to the LT PCC shall be through Sandwiched type Non-segregated Phase Aluminium Bus duct.

ii. For bus duct sizing following are the factors to be considered:

(a) Design ambient temperature of 50ºC.
(b) Final temperature of the bus-bars complying with requirements of IEEE C37.23-2003 / IS 8048.
(c) Suitability for carrying rated current continuously taking into consideration design margin. The current density (A/mm²) of the bus bar shall not exceed 0.8 for Aluminium bus.

iii. The bus duct shall be provided with necessary support structure with flexi bus duct at the termination ends. Space heater shall be provided inside the bus duct to avoid presence of moisture. GI earth stirps shall be provided for earthing of the non-current carrying parts of the bus ducts.

1.2.3.30 LT Panels

i. All Panels shall be indoor / outdoor type having incoming sectionalisation and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP42 for indoor and IP55 for outdoor as per IEC Publication 529. All LT Panels except for PCC shall conform to FORM 3B whereas PCC shall conform to FORM 4B as per relevant IS standard. The LT Panels shall be as per the IEC 61439 standard.

ii. The PCC panels shall be of internal arc type tested with Internal Arc withstands level at rated fault level for 0.3s as per relevant standards. The PCC panels shall be floor mounted, bottom entry type located at the ground floor electrical rooms of the buildings. The room shall be located close to the location of the CSS and AMF / Synchronizing panel.

iii. The floor distribution panel shall be floor mounted, bottom entry, indoor type panel located at the electrical room at respective floors. The sub-distribution panels such as lighting DB, power DB, UPS DB shall be floor / wall mounted with bottom entry type.Busbar: All panels shall be provided with Aluminum busbar. Distribution boards with incomers below and including 63A shall be provided with tinned copper bus bars.

iv. The bus-bars shall be sized considering the following criteria:

a) Sleeves made of insulating material on all bus bars.
b) Design ambient temperature 50ºC.
c) Final temperature of the bus-bars complying with requirements of relevant standards.
d) Bus bars being inside the panel; De- ration for enclosure and ventilation.
e) Bus bar suitability for carrying rated current continuously. The current density (A/mm²) of the bus bar shall not exceed 0.8 for Aluminium bus and 1.6 for Copper bus.
f) Configuration of bus bars and Proximity effect.
g) The main bus shall be designed based on the load rating as well as the actual fault level for specified duration at the location of the panel with 10% positive tolerance.
h) Earth bus of the panel shall be sized suitable for the above fault level for the same duration.

v. Switchgear Sizing/ Selection: Switchgear shall be sized/ selected considering the following:

(a) Rating suitable for carrying full load current of the equipment / feeder.

(b) Suitability for Short Circuit Rating for specified duration.

(c) Switchgear for motors shall be suitable for motor duty application with Type – 2 co-ordination.

(d) In panel de-ration of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.

(e) Switchgear rating for individual capacitor bank shall be sized at 1.5 times the rated current rating.

(f) ACBs shall be considered for switchgear ratings above 630A and MCCB shall be considered up to 630A. All ACBs and MCCBs shall be rated for Bus fault level or next higher market rating available with Ics=Icu=Icw=100% for ACB and and Ics=Icu=100% for MCCBs.

(g) Miniature Circuit Breaker (MCB) shall be considered where fault level is below 10kA.

(h) The Main LT Switchgear panel shall be provided with Microprocessor based overload (O/L), Short circuit (SC) and Earth fault (E/F) release at the panel incomer and outgoing.

(i) For One Stop Rourkela buildings, critical and sensitive loads such as drives, PLC.s, automation panels, etc require protection with SPD in addition to SPD at incoming power panels and sub-distribution boards. SPDs shall be selected to meet the requirements of relevant LPZs. Lifts, escalators, moving walks and fire panels shall be protected with SPD in control panels. All electrical and control panels related to safety and security of building shall be protected with appropriate SPDs. All SPDs should have status indication to show their healthy state for discharging the lightning current.

(j) Multi-function meter for measuring current, voltage, power, frequency, harmonics shall be provided for all the incomers (Transformer as well as DG), outgoing power / tie feeders. Ammeter shall be provided for other load feeder such as motor feeder, lighting feeder, etc.

(k) Motor starter selection shall be done as follows:

i. Direct On Line (DOL) Starter – For motors rated up to 5.5 kW

ii. Star- Delta Starter - For motors rated above 5.5 kW to 45 kW or as per local Electricity board requirements, whichever is more stringent.

iii. DOL starter shall be provided for the main Fire Pump.

iv. DOL starter shall be provided for Jockey pumps.

(l) Motor feeders shall have the following protection and components:

i. Motor Protection Circuit Breakers (MPCBs) with inbuilt thermal overload and air break contactors for motors up to and including 50 kW rating suitable for type 2 co-ordination.

ii. MCCB with separate thermal overload and air break contactors for motors above 50kW up to and including 100 kW rating suitable for type 2 co-ordination.

iii. ACB/MCCB and Composite motor protection relay (a minimum of protections such as over current, short circuit, earth fault, locked rotor, Negative phase sequence, thermal alarm etc.) for motors above 100kW rating.

iv. For fire pump, overload relay shall be provided with a plug setting of 110%.

(m) In case the fault level at transformer LT side increases to more than 10kA, cascading of breakers so as to accommodate MCBs in the PMCC shall be adopted. This shall ensure cost saving.

(n) 20% spare capacity shall be considered on each panel for future.

1.2.3.31 UPS and Battery Sizing

i. UPS shall be rated with reference to the running load with a contingency of 10% and loading up to 80% for normal operation.
ii. Battery sizing shall be done considering following factors:
   a) Design Margin – 1.2
   b) Aging Factor – 1.25
   c) Temperature derating factor for 50 deg C – 0.91
iii. Command and Control Centre building shall be provisioned with modular type UPS whereas the other buildings shall have conventional non-redundant type UPS. The UPS shall cater to critical loads and emergency lighting loads.

1.2.3.32 Cabling System

i. HT cables shall be 33kV earthed grade, multi-core, stranded and compacted aluminium contractor, extruded XLPE insulated (dry cured), extruded semi conducting compound screen with a layer of non-magnetic metallic tape screen, extruded PVC inner sheath (Type ST-2), armoured and extruded overall sheath with Fire Retardant Low Smoke (FRLS) PVC compound (Type ST-2). The cables shall conform to IS-7098 Part -II.
ii. LT Cables shall be 1100V earthed grade, single/multi-core, stranded and compacted aluminium conductor, extruded XLPE insulated, extruded PVC inner sheath (Type ST-2), armoured and extruded overall sheath with Fire Retardant Low Smoke (FRLS) PVC compound (Type ST-2). The cables shall conform to IS-7098 Part -I.
iii. All LT cable shall be conforming to IS 7098 Part I for XLPE cables and IS 1544 – Part I for PVC cables.
iv. Cables up to & including 6.0 mm^2 shall be Copper multi-stranded conductor with PVC insulation galvanized steel round wire armoured & cables including and beyond 6 mm^2 shall be Aluminium multi-stranded conductor with XLPE insulation & galvanized steel flat strip armoured.
v. All control cables shall be 650 V grade copper conductors FRLS PVC insulted cables conforming to IS 1544- Part I. For cables above 7 cores, minimum two spare cores shall be considered.
vi. The following main aspects shall also be considered while deciding the size of the cables:

(a) Supply voltage and frequency.

(b) Corresponding full load current under site conditions, i.e, necessary de-rating considerations.

(c) Route length and method of laying of cables.

(d) Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/ PVC).

(e) Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.

(f) Following shall be the fault clearing time consideration:

   (i) From HT breaker to Transformer Primary shall be 0.16s.

   (ii) From transformer secondary to Power Control Centre (PCC) incomer shall be 1s.

(iii) From ACB outgoing of the PCC shall be considered as 0.16s (for Tie feeders if any it shall be 0.5s).

(g) Appropriate de-rating factors as per cable manufacturer's catalogue and enlisted below shall be considered for sizing the cable:

(i) Ambient Air Temperature (minimum 50ºC).

(ii) Ambient ground temperature (minimum 40ºC to be considered).

(iii) Method of cable laying.

(iv) Depth of cable burial (minimum 750 mm for LT and 1200 mm for 33kV HT).

(v) Thermal Resistivity of Soil (minimum 150ºC Cm/ W to be considered).

(vi) No. of cables in a group

(vii) No. of cable trays in tier.

(viii) Any other de-ration factors as applicable & as per Manufacturer's catalogue.

vii. Bending radius of 12D and 15D shall be provided for LT & Control Cables and HT cables respectively where D is the outer diameter of the cable.

viii. Bending radius of 12D and 15D shall be provided for LT & Control Cables and HT cables respectively where D is the outer diameter of the cable.

ix. The cable from 4 pole structure to each building MRMU shall be laid in DWC HDPE Pipes, as per IS 14930 Part II / IS 16205 Part 24 latest edition, with manholes in coordination with other external services. These pipes shall be preferable laid beneath the footpath area with manhole covers being designed to be camouflaged with the footpath.

x. The connection from CSS and DG synchronizing panel / AMF panel to Main PCC Panel shall be through bus duct. The cables connecting Main PCC panel to other distribution boards/ equipments /Floor panels shall be either through cable trays or recessed conduits. RCC pipes shall be provided where cables need to cross the roads, drive ways. For HT cables, one cable shall be laid in one pipe section of minimum 150mm internal diameter. LT, control and ICT cables shall be laid in separate pipes with occupancy of each pipe being limited to 70%.

xi. Cable routing

a. The first consideration in cabling system layout is to keep the distance between the source and the load as short as possible. Many other important factors will also be taken into account to arrive at the lowest cost system that operates within the reliability, safety, economy, and performance factors that are required.

b. Route selected must not pass close to sources that produce significant heat like steam pipes, etc. Also the route must not interfere with utility systems like Water, HVAC, fire hydrant etc. and civil structures.

c. The cable tray sizes shall be selected on the basis of the number and sizes of cables to be carried with the due consideration to the following cable laying arrangements.

- All HT power cables are laid in a single layer with 1D Spacing between each other.
- All LT power cables are laid in a single layer touching each other.
- All control cables are laid in three layers touching each other.

- Power and control cables are laid in separate trays for the purpose of segregation.

d. All the cables outside the building premises shall be laid in DWC HDPE pipes lay beneath the carriage way. The pipe size determination shall be based on the table below:

Sr. No.	Voltage level (kV)	Occupancy (%)	Max. No. of Cables per pipe
1	33	40	1
2	0.415	30	As per occupancy requirement

e. DWC HDPE pipes shall be buried beneath the footpath / carriage way (as per space availability in the same order of precedence) with different layers for each voltage level. The voltage grading shall be 1.1kV (LT) on the top about 900 – 1000mm below the Finished Road Level (FRL) followed by subsequent voltage level of 33kV.

f. A cable connection chamber for terminating, jointing and bending of cables shall be provided. The chamber size shall depend on the intended usage. The location of these chambers shall be:
   - At every 30m distance for straight run of cable or depending on the cable drum length
   - At RMU cable termination
   - At Road Junction or turning

g. The distance between subsequent chambers shall be varied as per site conditions to meet the above requirements. The chamber shall be made of RCC with openable cover having capability to cater to the vehicular movement proposed over it. Arrangement shall be provided for 1-2 personals to enter into the chamber and carry out necessary repair / maintenance activities.

h. Within buildings, the cables shall be laid in prefabricated galvanized steel, perforated type cable trays, suitably supported by painted steel cable tray supports supported from wall/ ceiling/ columns etc as per site condition. Separate cable trays will be used for 415V power cables and control cables.

i. All road crossings shall be carried out with cables laid in a RCC Hume pipes. Proper encasing shall be considered for pipes laid below 1m depth from FGL.

1.2.3.33 Motors

All motors shall be 3 phase, 415 V squirrel cage energy efficient IE2 induction type having TEFC IP55 enclosure with Class-F insulation limited to Class B temperature rise conforming to IS 12615:1989.

1.2.3.34 Earthing & Lightning Protection system

i. The earthing system shall comprise one or more earth electrodes, earthing network, mesh or a combination of these in order to obtain grid resistance of less than 1Ω.

ii. Latest version of following standards and codes shall be referred to for designing the Earthing and Lightning protection system:

IS 3043	Code of practice for Safety Earthing
IS/ IEC 62305	Code of Practice for the protection of buildings and allied structures against lightning.
CEA guidelines 2010	Measures related to safety & electric supply.
IEEE 80	IEEE Guide for Safety in AC Substation

iii. **Soil Resistivity:** The earthing system shall be designed by considering measured soil resistivity during detailed engineering and the earthing calculation shall be done.

iv. **Size of Earthing Conductors:** The earthing conductor sizes shall be calculated as per IS 3043. Following factors will be considered for sizing the earthing conductor:

Design Ambient Temperature	50°C
Allowable temperature rise	500°C
For steel welded joints (Fault clearing time)	1.0 s
Overall earthing resistance of the grid for the following installations	As per IS 3043 / Local regulatory requirements

v. The maximum values of earth fault current for the design of the earthing system will be considered based on system requirement as follows:

a) 33 kV system : 25kA for 1s

b) 415 V system : 35kA for 1s (will be decided as per actual fault level calculation)

vi. The galvanising of the earthing material will be done as per IS 2629-1985.

vii. The soil around the earth electrode shall be treated with common salt & charcoal in alternate layers as per requirement.

viii. Buried earthing conductors around the periphery of each building shall be installed at a minimum depth of 600mm at a distance of approximately 1500 mm from the building edge.

ix. Earthing leads of transformer neutral will be connected to two separate earth electrodes. The earthing leads of transformer body will be directly connected to main earth grid.

x. Earthing network shall also be connected / formed through the cable trays. Double run GI strips (of adequate size as per the fault level) shall be laid on the cable tray along the length. The strips shall be welded to the cable tray at every 10m interval. For multi-tier trays, the strip can be laid in one tray and connected to all other trays at 10 M interval. These strips shall be connected to the main earthing grid buried around the building at minimum two places.

xi. Earthing requirements for Conduit wiring for Sub main, circuit and point wiring shall be carried out as per OPWD guidelines.

xii. Different locations (including utilities)

- For outlying areas, main earthing conductor will be installed around the building periphery in the form of a ring.
- Minimum two tap-offs will be provided for connecting with the earthing conductor inside the building connected to the earthing conductor embedded in the floor slab with approximately 50 mm concrete cover.
- Cross conductors that divide the entire floor area into a grid will be planned to provide earthing connection to all equipment and structures by short and direct earthing leads.
- In case, the building has more than one floor, each floor will be provided with earth grid as discussed above. All floor earthing grids will be interconnected.

xiii. Each RCC/Steel column of the building will be connected to the floor earthing grid in the basement / ground floor.

Design Considerations

xiv. Earth Grid Conductors sizing: The main earth grid conductor sizing shall be done based on the maximum fault current that the conductor must withstand in a given time for a specific system.

xv. Grounding Electrodes: Earthing system shall be designed on the basis of the fault level and soil resistivity of the system as per Indian Standards 3043. Separate earth pit shall be designed for transformer, Motors, Lighting poles and all other electrical equipment and should be connected with the earth bus of the system.

xvi. Equipment Grounding conductors: The cross-sectional areas of the conductors of the protective circuit are influenced by the limitation placed on earth loop impedances to ensure disconnection of the circuit in which an earth fault occurs in the prescribed time i.e., instantaneous disconnection and it is also necessary to ensure that the circuit protective earth conductor is protected against the thermal effects of the fault current. Thus, Equipment earth leads shall be sized considering maximum let through ground fault current allowed by the protective device of associated equipment and from the point of view of mechanical strength.

xvii. Electronic Equipment Earthing: The electronic earthing shall be provided for electronic equipments. A separate earthing grid shall be formed for electronic equipments and connected to a separate treated earth pit with copper electrode. This in turn will be connected to the common earth grid.

xviii. The material for the earthing conductors will be as follows:

S. NO.	EARTHING CONDUCTORS	MATERIAL USED
a.	Conductors above ground	Galvanised Iron (GI) flat strip capable of withstanding fault level for 1s
b.	Conductors buried in ground	Galvanised Iron (GI) flat strip capable of withstanding fault level for 1s
c.	Conductor connecting electrical equipment body to the Main Earth Grid or earth pit	Galvanised Iron (GI) flat strip capable of withstanding fault level for 1s
d.	Conductor connecting electrical equipment neutral to earth pit	Cu flat strip capable of withstanding fault level for 1 Sec
e.	Pipe electrodes for treated earth Pit	Galvanised iron (GI)
f.	Plate Electrode for treated earth pit	Galvanised iron (GI) / Copper (Cu)
g.	Rod electrode for Non-Treated Earth Pit	Mild Steel
h.	Lightning protection air termination and down conductor	GI flat strip of 25 X 6mm

1.2.3.35 Lightning Protection

i. The need for lightning protection system shall be established by calculating the risk factor value of each building, structure etc. as per methodology/ procedure prescribed in IS/IEC 62305 - 2010. This will be provided for building(s) whose risk factor is exceeding the limiting values. The Risk factor shall be evaluated for Level 2 risk.

ii. Based on the calculation, if found necessary, air termination system comprising of roof conductors shall be provided. The horizontal mesh shall be provided as per IEC 62305 - 2010

above the roof. The down conductors for this system shall be fixed and run along the outer surface of the building and connected to the earth electrodes.

iii. The function of the air-termination systems of a lightning protection system is to prevent that direct lightning strikes damage the volume to be protected. They must be designed to avoid uncontrolled lightning strikes to the building / structure to be protected. Air-termination systems can consist of the following components and can be combined with each other as required:

(a) Roof conductor / rods / Meshed conductors / Air termination

(b) Down conductors

(c) Earth termination

iv. All connection between the conductors shall be welded/brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.

v. Earth pits provided for down comers of lightning protection will be connected with general earth pits through earth strips below ground to reduce the overall earthing resistance of the grid.

1.2.3.36 Point Wiring

i. Internal point wiring to light point/Fan point/ Exhaust fan point/Call bell point with 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20 mm dia non-metallic PVC flexible conduit with 6Amp, 250V Modular switch ISI marked and ceiling rose ISI marked mounted on metal box having front Modular cover of suitable size, metal box with 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor as earth wire including all accessories and connection.

ii. Lighting in external areas shall be installed using 1.1kV multicore armoured cable of suitable sizes.

iii. Small Power Outlets:

- Switched single phase three pin 6 A and 16A receptacles shall be provided throughout. In offices and control rooms they shall be the decorative type and industrial type in all other areas. The number of such outlets shall be as follows, unless additional numbers are required for specific loads:

- 6 A type one outlet per 5 m or part thereof of perimeter in offices;
- 6 A type one outlet per 20 m or part thereof of perimeter in all other areas;
- 16 A type one outlet per 20 m or part thereof of perimeter in offices;
- 16 A type one outlet per 20 m or part thereof of perimeter in all other areas.
- 32 A switched three phase and neutral receptacles shall be provided in Switchgear room, where appropriate.
- For Split Air conditioners 32 A, 1 Ph decorative Switch Socket shall be provided per equipment as suitable.

- The location of outlets shall be approved by the Engineer-in-charge. The spacing of 5 A and 15 A outlets shall be arranged to suit the intended location of equipment, desks etc.

- Receptacles for outside areas shall have a degree of protection of IP 65. Outdoor receptacles shall be provided in the landscaped area for grass cutting and other maintenance functions. Outdoor receptacles shall be provided in the stage area of the open-air theatre as per relevant standards or requirement.

- The 6A light plug shall be installed with 2 x 2.5 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20mm dia non-metallic PVC flexible conduit along with 1 x 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor for loop earthing as required.

- The 16A power plug shall be installed with 2 x 4 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20mm dia non-metallic PVC flexible conduit along with 1 x 2.5 sq.mm FRLS PVC insulated single core multistrand copper conductor for loop earthing.
- **For workstation area –**
    a. Two (2) nos. UPS points (2 nos. of 6/10/13A Sockets with switches) and One (1) No. Raw power socket point (1 No. 6/10/13A socket with switch) is considered per workstation. Four (4) nos. of such workstations are considered on one single phase circuit of UPS workstation DB whereas, 8 nos. of raw power receptacles (6A) are considered on one single phase circuit of raw power receptacle distribution boards.
    b. Two (2) nos. RJ-11Telephone outlets shall be provided from the proposed Krone Box per Workstation.
    c. Two (2) nos. RJ45 outlets for LAN connectivity shall be provided per Workstation connected by high speed Systimax Giga SPEED XL CAT-6 UTP cable or better option.
- **Kitchen / Cafeteria** - 32A power receptacles shall be provided for equipments and other facilities as per relevant regulations or direction of Engineer-in-charge.
- **Rooms / Dinning Area** – 6A and 16A power receptacles to be provisioned for TV, set top box, AC, Hair dryer, charging point (at ends of the bed), Fridge, etc as per Architectural Requirements.

1.2.3.37 Illumination System

a. Latest version of related IS standards, NBC and National Lighting Code (NLC) shall be referred for designing Illumination for different areas.
b. All lighting design shall be carried out on Dialux latest version. Soft copies of Dialux files for each calculation shall be submitted for review.
c. All lighting fixtures shall be of LED type.
d. Emergency Lighting: 25% of lighting load shall be considered as emergency lighting load and shall be catered through a UPS. Exit lights shall be provided so as to ensure safe evacuation in the event of fire, accident, etc. These exit lights shall also be powered through the UPS. The UPS shall be sized adequately with battery backup of about 15 minutes.
e. The basis of design shall be based on the following lighting engineering criteria, as per relevant standards or specified herewith:

- Lighting lux level
- Luminance distribution
- Glare restriction
- Direction of incidence of light and shadow effect
- Color appearance and color rendering of the light source
- Uniformity

f. Illumination Level: The following type of LED luminaires shall be provided for various areas in order to achieve the average illuminance as per various relevant lighting standards or those indicated below, which ever being stringent:

Sr. No.	AREA	Average illuminance (Lux)	Type of Fixture
i.	Utility Areas of building like Electrical Room, Store Room, Pump House, Ventilation / AHU Rooms, Metering rooms, UPS room, material handling etc	200	Surface / Recess mounted LED batten type
ii.	Common areas – Corridor and Lobby, Passage, Toilets, Staircase, etc	100	LED Surface / Recess mounted decorative down lighter fitting with polycarbonate cover, LED Mirror Lights in toilet
iii.	Control room, Video Hall	500	Surface / Recess mounted LED decorative light fitting with polycarbonate cover
iv.	Board Room/ Teleconference, VIP lounge, DC Server Farm area, office areas	300	Surface / Recess mounted LED decorative light fitting with polycarbonate cover
v.	Suite Rooms, Guest Rooms, Green Rooms, Visitors area	250	Surface / Recess mounted LED decorative light fitting with polycarbonate cover Mirror Light Spot lights Reading light
vi.	Convention Hall	300	Surface / Recess mounted LED decorative light fitting with polycarbonate cover
vii.	Auditorium Hall	150	LED Surface / Recess mounted decorative down lighter fitting with polycarbonate cover with dimming feature Architectural light fixtures such as step lights, wall washers. Up down lighter, spot lights
viii.	Library	300	LED Surface / Recess mounted decorative down lighter fitting with polycarbonate cover Spot lights near the racks
ix.	AV Room	200	LED Surface / Recess mounted decorative down lighter fitting with

Sr. No.	AREA	Average illuminance (Lux)	Type of Fixture
			polycarbonate cover with dimming feature Architectural light fixtures such as step lights, wall washers, spot lights
x.	Waiting area , Reception	200	LED Surface / Recess mounted decorative down lighter fitting with polycarbonate cover
xi.	Parking-Basement	50	LED Surface / Recess mounted decorative down lighter fitting with polycarbonate cover
xii.	Street lighting	10 – 15	30W LED post top on 5 mtr. GI Pole P.U. Painted similar to Philips BGP161 LED2300/WW PSU
xiii.	Landscape	10	1x12W LED angle adjustable spot lighters Philips BGP 310, 9W LED Bollards similar to Philips BCP151 1x8W tree up lighters similar to Philips BBP 330, step lights similar to Philips BWG150
xiv.	Open Air theatre	30	Outdoor area flood lighting, uplighters, path-finders, bollards, post top lights as per Architectural requirement

g. Following factors shall be considered while arriving at the utilization factor to determine the number of fixtures for each area/ building:

Maintenance Factor:

- Indoor Area Lighting with LED Luminaire : 0.8
- Outdoor Area Lighting with LED Luminaire : 0.7

Reflection factor for Indoor Lighting to be considered are as follows:

- Ceiling : 0.5
- Walls : 0.3
- Floors : 0.1

However Reflection factor can be selected based on the Color of the wall and Ceiling as given below:

- White and very light colors : 0.7
- Light colors : 0.5

- Middle tints : 0.3
- Dark colors : 0.1

h. Room index at applicable surface reflection factors need to be considered.
i. The working plane shall be considered at 0.75 m from the floor level.
j. Uniformity factor shall be considered as per National Lighting code/NBC/IS code.
k. The power supply for lighting shall be distributed from Lighting Distribution Boards located inside each unit.

l. Specific Requirements:

- Command and Control Centre: The building shall have office lighting using downlighters. To ensure saving of electrical energy, occupancy sensors shall be provisioned to control the lights. The lights shall also have dimmable feature to enable day light saving. The luminaries should also have localized switch on/off control provisioned. The luminaries of an area may be grouped controlled. The position of the luminaries shall be such that it does not have glare on the user.

  The suite rooms shall be provisioned with decorative downlighters for room lighting. Spot lights for reading purpose shall be provisioned at adequate locations. Mirror lights shall be provided in the drawing and bath rooms. LED cove lighting shall be provided on the false ceiling to provide indirect lighting.
- Auditorium: The auditorium lighting shall be using step lights, decorative down lighters with dimming feature, wall washers, uplighters. During a video streaming event, the auditorium lights shall be dimmed with only the step light being on for guiding purpose. The step lights shall be provisioned along the rear seats to the passage, passage in a manner that the throw of the light is downward to illuminate the path. During live stage event, the hall lights shall be dimmed as per the requirement. Flood lights or high bay lights shall be provisioned as per requirement. The Auditorium stage lighting shall comprise of the architectural lighting fixtures. Adequate catwalk feature shall be provided for maintenance purpose.
- Tribal Museum: The museum lighting scope shall comprise of normal lighting. The necessary architectural lighting for the murals, paintings, etc shall not be in the Contractor's scope. Adequate power receptacles or points, as per Engineer-in-charge, should be provisioned in the museum.
- Stage Lighting System: Stage will have Lux levels adjustable from 0 to 2000 Lux based on requirement of Stage lighting. The CONTRACTOR shall design the stage lighting considering the functional usages proposed as per relevant codes / regulations / standards. The CONTRACTOR shall submit relevant referred references. Auditorium Lighting to be designed for events like:

  - Lighting for the Live Performance.
  - Lighting for Drama / Dance / Singing & Multipurpose use.
  - Presentation and Speech.
  - Live Control through DMX for Lighting Fixture with Multiple universes.
  - RGB Illumination and High CRI Based Profile spots
  - Video streaming

1.2.3.38 Lighting Power Distribution

(i) For indoor area, lighting power distribution should be through 415V, 3 phase, and 4 wire lighting distribution boards. These LDBs shall be located at an interval of 30m, catering to lighting load requirements within a radius of 15m.

(ii) The lighting system which will essentially comprise the following two (2) categories:
   (a) Normal 240V AC Lighting System.
   (b) Normal-cum- emergency 240V AC Lighting System.

(iii) Normal 240V A.C. Lighting
   (a) This will be provided by A.C. lighting fixtures proposed for various buildings and common area. These lights can be switched ON as long as the A.C. supply is available.
   (b) A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be fed from PCC / Main Lighting Distribution Board. Normal A.C. supply thus made available by the MLDB is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB and the lighting panels will be provided with at least 20% spare outlets.

(iv) Normal cum Emergency AC Lighting
   (a) On failure of normal A.C. supply as well as D.G. supply, A.C. lighting will be provided in critical accessing areas for general visibility, safe movements.
   (b) At least 25% of the fixtures will be fed from this Normal cum Emergency AC Lighting Boards.
   (c) Emergency lights shall be envisaged at strategic points viz., near entrances, staircases, control rooms, passage / corridor etc. These would be fed from UPS systems.

1.2.3.39 Elevator

Elevators shall be provided at the buildings as per Architectural drawings. The elevators shall be machine room less type with travel speed of 1.5m/s or as per NBC 2016. The number of stops, height of travel, etc shall be as per the Architectural requirements.

1.2.3.40 Performance criteria

(i) General

(a) The contractor shall carry out the work in accordance with detailed design and Good for Construction drawings to be prepared by the Contractor.

(b) The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required result.

(c) The contractor shall guarantee that the Electrical system as installed shall perform to complete satisfaction of the owner.

(d) The contractor shall also guarantee that the performance of various equipments individually, shall not be less than the quoted capacity; also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.

(e) Rating of all items shall be appropriate for the conditions on the particular site on which the item will be used. All the equipment shall be fit for continuous work under the most severe weather conditions of site.

(f) The Contractor shall hold himself fully responsible for reinstallation or replacement free of cost to Owner the following:

- Any defective work or material supplied by the Contractor.
- Any material or equipment damaged or destroyed as a result of defective workmanship by the Contractor.

(ii) MANUFACTURERS

(a) All the electrical equipments to be supplied under this contract have to be of reputed makes. The equipment of those manufacturers, who have sufficient proven experience of manufacturing the respective equipment of similar capacity, shall be considered. The respective equipment should have been manufactured, supplied, installed, commissioned successfully and should be running satisfactorily since at least last 5 years continuously. Certificates from end users, regarding their satisfactory Performances, shall have to be submitted in this regard.

(b) Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

(c) Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required.

(d) For items not covered under the List of Approved Makes, contractor shall offer items of first-class quality, standards and performance and obtain the approval of Construction Manager/Consultants before procuring them.

(e) Where interfacing occurs, equipment shall be mutually compatible in all respects.

(iii) DISTRIBUTION TRANSFORMER

(a) Transformers shall operate without injurious heating at the rated kVA at any voltage within + /- 10 percent of the rated voltage of that particular tap.

(b) Transformer shall be capable of delivering rated current at a voltage equal to 105% of rated voltage.

(c) Transformers shall be designed for operation at a frequency of 50 Hz.

(d) Transformers shall be designed for 110% continuous over fluxing with stand capability. Transformers directly connected to the generators shall in addition shall have an over fluxing capability of 125% for 60 seconds and 140% for 5 seconds.

(e) Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminals, tap changers or other auxiliary equipment shall apply.

(f) The maximum losses shall minimum of that of losses given in ECBC 2017. The permissible tolerances on the guaranteed values of transformer losses shall be as per IEC.

(g) Transformer shall be self-extinguishing in the event of fire or arcing.

(h) Transformer shall have partial discharge level of less than (10pC).

(i) Transformer shall be of low no load loss & low noise. Values of noise level & testing shall be as specified in IEC/applicable standards.

(j) Transformer shall be certified for following:

- Class F1: - “Fire Behavior”
- Class C2: - “Climatic”
- Class E2: - “Condensation and humidity”

(k) Contractor to confirm the suitability of the transformer for high inductive loads (high current, short time, unbalance loads).

(l) Transformer shall be suitable for switching with Vacuum Circuit Breakers (VCBs). Resonance frequency of the winding shall be such as to avoid resonance with the switching impulse of VCBs & overstress of the insulation.

(m) The sound level of the transformer shall not exceed the limit indicated by NEMA – TR1 standard under any specified operating conditions.
(n) The Contractor shall guarantee the declared efficiency of the transformers.
(o) The temperature rise shall be restricted to 40 degrees Celsius above ambient. Trip setting at full load shall be at 35 degrees Celsius above ambient.

(iv) LIGHTING FIXTURES: There shall be 5 years replacement warranty for LED lighting fixtures.
(v) POWER CONTROL CENTRE/APFC PANEL
(a) The Contractor shall give a guarantee for trouble free operation of the equipment offered under stipulated operating conditions. All measuring instruments to be used for performance test shall have certified accuracy of + 0.5 % and shall be arranged by the Contractor during the test.
(b) The Contractor shall give a guarantee for temperature rise inside the panel as per design basis during actual performance test at supplier's works.
(c) The panel shall be 4B enclosure.
(vi) HT/ LT POWER CABLES AND CONTROL & INSTRUMENTATION CABLES

The Contractor shall give a guarantee for trouble-free operation of the Cables offered under the stipulated operating conditions and fulfill guaranteed technical parameters/performance.

1.2.4 AIR CONDITIONING & VENTILATION SYSTEM

1.2.4.1 SCOPE

This section covers Air-conditioning & Ventilation system proposed for Rourkela one at Rourkela, Odisha under Smart City Mission. Areas covered under HVAC system are as under:

- Auditorium Building
- Command Control Centre (CCC) &
- Tribal Museum

The Bidder shall satisfy himself regarding the equipment capacity required for maintaining the end conditions inside air conditioned and ventilated spaces before submitting their offer. The Bidder shall have to guarantee the end conditions mentioned in following clauses. The location of air conditioning & ventilation equipment, layout of ducting, piping etc. shall be designed by the Bidder and approved by the Consultant / Owner. Bidder to check location of indoor & outdoor units, adequacy of shafts for refrigerant pipe routing, exhaust of air etc. as per architectural drawings. In case of any observations / modifications required on the same, Bidder to indicate along with their technical offer. Afterwards no changes / modifications will be entertained in the layout.

Any items or parts whether specifically mentioned or not but required for functional completeness of the system, shall be provided by the successful Bidder as a part of the contract.

1.2.4.2 DESIGN BASIS

DESIGN AMBIENT CONDITIONS:

Following outside design condition shall be considered for cooling load estimation (as per ISHRAE handbook):

Season	Summer	Monsoon	Winter
Dry Bulb Temperature (DBT) (^{0} C)/ (^{0} F)	43.3 / 110	30.55 / 87	12.22 / 54
Wet Bulb Temperature (WBT) (^{0} C)/ (^{0} F)	25.5 / 78	27.78 / 82	6.67 / 44
Relative Humidity (RH) (%)	24	80	41

HANDLING FACILITY

All the equipment will be provided with suitable lugs & lifting tackles for ease of handling for erection and maintenance purpose. The components of the equipment will be so designed to enable them to be handled easily with the conventional handling facilities.

ANCHOR, BOLTS, INSERTS ETC.

Anchor, bolts, inserts etc., as required, for installation of the equipment, duct, pipe and accessories will be provided by the HVAC contractor.

SYSTEM BALANCING

(a) System balancing is a process for maintaining the performance of an HVAC system and for providing the occupants with a comfortable conditioned space. Construction documents shall require that all HVAC systems to be balanced in accordance with generally accepted engineering standards. Construction documents with written balance report to be provided to the Purchaser for HVAC systems.

(b) Construction documents with following information to be provided to properly operate & maintain the system that has been properly balanced.

- HVAC equipment capacity
- Equipment operation & maintenance manuals
- HVAC system control maintenance & calibration information including wiring diagram, schedules & control sequence descriptions
- Complete written narrative of how each system is intended to operate

OTHER SERVICES TO BE PROVIDED BY HVAC CONTRACTOR

- Making minor wall /slab openings for passage of duct /pipes & making good of the same.

- Sealing of the balance opening by rock wool and fire retardant seal after duct /pipe erection.
- Scaffolding as required.
- Weather proofing and painting of structural supports of outdoor units as directed by engineer/consultant.

DURATION OF OPERATION

The Air conditioning & Ventilation System shall be designed considering continuous operation. However, depending upon the actual requirement, duration of operation of HVAC equipment shall be finalised.

NOISE AND VIBRATION

(a) The design of all equipment and accessories shall ensure of noise and vibration levels within the limits as per latest codes and standards. Noise level inside equipment plant room shall be limited to 85 dB (A) at a distance of 1.5 m and noise level at supply air grilles inside air conditioned space shall be restricted to 65 dB (A) when measured at a distance of 1.5 m.
(b) The overall vibration level shall be as per zones A and B of ISO 10816-1.

1.2.4.3 CODES AND STANDARDS

Equipment covered in this section shall comply with latest edition of the appropriate equivalent international standards, all currently applicable statutes, regulations and safety codes in the locality where the equipment shall be installed with particular reference to those set out below:

Sl. No.	Standard	Description
1.	NBC : 2016	National Building Code – Air- Conditioning & Fire Protection
2.	ASHRAE standard 90.1-2016	Energy standard for buildings except low rise residential buildings.
3.	ASHRAE 55	Thermal comfort
4.	AHRI -1230 Standard	Performance Rating of Variable Refrigerant Flow Units.
5.	ASHRAE Handbooks	American Society for Heating, Refrigerating and Air- Conditioning Engineers.
6.	IS: 655/SMACNA	Duct construction standards

7.	ASHRAE 52.2-2012	Air Filters
8.	IS 277	GI Sheet
9.	ASHRAE Standard 62.1-2016.	Ventilation for Acceptable Indoor Air quality
10.	ECBC 2016	Energy Conservation Building Code
11.	ISHRAE	HVAC Handbook - Air conditioning & Ventilation
12.	IS: 661	Thermal Insulation for Cold Surfaces
13.	IS 2312	Propeller type ventilation fans
14.	IS 3588	Electric axial fans
15.	IS 4894	Centrifugal fans
16.	UL 555	Fire dampers
17.	IS 12065	Permissible limits of noise level for rotating electrical machines
18.	IS 12075	Mechanical vibration of rotating electrical machines

1.2.4.4 AIR-CONDITIONING SYSTEM

Variable Refrigerant Flow (VRF) type air-conditioning system has been considered to meet the air-conditioning requirements of the above buildings. Outdoor units shall be located at the Terrace of the respective building. No stand-by units have been considered for selection of outdoor / indoor units.

DESIGN PHILOSOPHY

The capacity of Air-conditioning equipment shall be designed as per the Design Philosophy & equipment specification elaborated below.

(a) Interconnecting insulated refrigerant pipework from respective ODU to individual IDUs shall be routed through vertical shaft / outside the building. Space for housing the indoor units shall be provided at the respective floor where floor mounted ductable units to be considered. For other areas ceiling suspended cassette type indoor units shall be considered.

(b) The indoor air quality of air-conditioned areas served by the air conditioning units, shall be as per ASHRAE Standard – 62.

(c) Lighting load for AC System shall be considered as 10 watt/sq.M (or actual) for all the areas.

(d) Occupancy shall be considered as per actual / ASHRAE standard.

(e) Solar and transmission load through walls, roofs, doors, windows, glazing, floors etc. shall be considered.

(f) Conditioned air shall be distributed through insulated supply air duct along with diffusers / grilles / jet air nozzles, as per requirement. Return air shall be taken back to the respective AHU room from the area above false ceiling, wherever necessary.

(g) Motorised fire dampers having fire rating of 90 minutes shall be provided wherever duct crosses any wall/roof.

(h) Supply air ducting shall be designed based on equal friction method to have an velocity not exceeding 8 m/s. Return air ducting, if necessary, shall also be designed based on equal friction method to have an velocity not exceeding 6 m/s.

(i) External surfaces of all metallic parts (equipment, piping & valves, supports etc.) shall be painted with three coats of synthetic enamel paint over a coat of suitable primer.

(j) Each air-conditioning equipment shall be interlocked with fire detection systems, so that in case of fire respective fans can be automatically tripped upon receipt signal from FDA Panel.

1.2.4.5 VENTILATION SYSTEM

DESIGN BASIS

a) Ventilation systems shall be designed based on required air change per hour (ACPH) OR heat load basis to maintain 5°C over & above ambient temperature, whichever is higher. However, Toilets, Pantries, Stores shall be ventilated on the basis of air change only.

b) AIR CHANGES PER HOUR (ACPH):
Minimum ACPH of the ventilated areas shall be considered as indicated below:

Sl. No.	Area	ACPH
1.	Toilet/Pantry/Kitchen	20
2.	Electrical Room /Pump Room /Store Room/Maintenance Room etc.	15

c) All ventilation systems shall operate on 100% fresh air.

DESIGN PHILOSOPHY

Ventilation system shall be designed as per the Design Philosophy & Equipment specification elaborated herewith.

a) Basement Car Parking Area

- For basement car parking, the fans & the ventilation system used for normal CO level ventilation, are also used for smoke ventilation during a fire. Hence, the extraction fans,

ancillaries & the system shall be rated for high temperature operation including ACPH requirements.

- Zone-wise ventilation system shall be considered for basement car parking area. Required nos. of dual mode exhaust air fans shall be installed in basement floor for exhaust of air from each zone. Fans shall be housed inside the fan rooms provided at basement floor. Ductwork with grilles shall be routed inside the basement floor & air shall be sucked & exhausted by the fans to the atmosphere through building shafts. Supply of air shall be through ramps & shafts provided at strategic locations inside the basement area. These fans shall be interlocked with CO sensors to be installed at the basement car parking area. The exhaust air fans shall be designed as per following ACPH:

  Normal Mode: 6 ACPH
  Fire / Emergency Mode: 12 ACPH

- During emergency mode, respective exhaust fan shall be operated at full speed in the basement from where smoke is to be removed quickly. Fire dampers shall be provided, wherever necessary. All of the fans will be controlled by HVAC monitoring & control system. The logic shall be arrived separately for normal mode and emergency mode.

b) Other Areas

- Each toilet shall be ventilated through ceiling suspended in-line ducted cabinet fan with necessary exhaust ductwork & grills / propeller fans, as per requirement. Exhaust of air shall be at the nearest shaft provided / outside the building. Exhaust grills/diffusers shall be provided in false ceiling, as applicable and intake air grills shall be provided in respective doors at lower level for entry of air.

- Electrical Rooms, Pumping Rooms, Store Rooms, Maintenance Room, Kitchen/Pantry etc. shall be ventilated through tube axial exhaust air fans & intake through louvers.

- Small Toilets shall be ventilated through propeller type exhaust air fans & intake air grills shall be provided in respective doors.

c) Exhaust air fan shall consist of fan with motor, rain protection cowl, bird screen etc.

d) Each ventilation fan shall be interlocked with fire detection systems, so that in case of fire respective fans can be automatically tripped through FDA Panel. All equipment shall be interfaced with fire detection and alarm system.

1.2.4.6 PERFORMANCE GUARANTEE

GENERAL

All equipment and systems of the Air-conditioning & Ventilation system shall be guaranteed for workmanship & materials and satisfactory performance for a period of 12 months from the date of successful commissioning/ handing over. The guarantee for performance shall cover individual

items/units and systems including electrics for their rated outputs as well as for integrated operations of the entire Air-conditioning & Ventilation system.

PERFORMANCE GUARANTEE PARAMETERS

(a) Actual Capacity at site for each AC & Ventilation equipment measured for a period of at least 7 days
(b) Total Power Consumption at design conditions / part load conditions
(c) Actual Capacity of each system at design conditions/simulated operating conditions
(d) Noise level
(e) Vibration level

OVERALL PERFORMANCE:

At an appropriate time in consultation with purchaser the successful Bidder shall demonstrate performance at rated capacity over a period of 6 working days on continuous operating hours.

Contractor will furnish performance guarantee for Air Conditioning & Ventilation System in respect of all items listed in Table below. The values indicated in Table below and the guaranteed performance curve will be the basis for evaluation of the performance tests by the Owner and/or acceptance of the equipment.

The following Performance Guarantees shall be confirmed by the Bidder:

Sl. No	Particulars	Value
1.0	Actual Capacity at site condition for each AC & Ventilation equipment	To be indicated by the Bidder
2.0	Electrical power consumption of each AC unit	To be indicated by the Bidder
3.0	Electrical shaft power of each ventilation unit	To be indicated by the Bidder
4.0	Noise level of each equipment	As per Spec
5.0	Vibration level of each rotating equipment	As per ISO Standard

Performance guarantees under correction

The following items of performance on air conditioning system shall be guaranteed under correction with instrument tolerances as specified below:

Sl. No	Particulars	Value
1.0	Room inside temp. of each air-conditioned space	± 1.0%
2.0	Shaft power of each motor	± 1.0%
3.0	Noise level	85 dBA at 1.5 m distance of any rotating equipment & 65 dBA at 1.5 m distance at supply air grilles inside AC space
4.0	Vibration level	As per zones A and B of ISO 10816-1

Note:

The values indicated by the Bidder should be the minimum guaranteed values without any negative tolerance.

MANPOWER

The manpower to be utilized for demonstration of performance guarantee shall be arranged by the Bidder.

MODIFICATIONS OF DEFECTS

If the tests specified above show that the performance of Air-conditioning & Ventilation system has failed to achieve all the guaranteed parameters or some of them, the successful Bidder shall rectify the defects and carry out modifications if necessary to meet the guaranteed figures and the guarantee tests shall be repeated at no extra cost.

However, protocol on this subject jointly agreed by the Purchaser and the successful Bidder will be prepared before the performance guarantee test.

1.2.5 INFORMATION & COMMUNICATION TECHNOLOGY (ICT)

The scope consists of design, engineering, built, supply, testing and commissioning at site, operations & maintenance of all ICT components for the period of 5 years after final acceptance testing of services :

1. **Fire Detection & Alarm System (FDAS)** in entire building of ICCC and Auditorium & Convention Hall of ROURkela one .
2. **Closed Circuit Television (CCTV)** at entire building of ICCC and Auditorium & Convention Hall of ROURkela one .
3. **Public Address System (PAS)** at entire building of ICCC and Auditorium & Convention Hall of ROURkela one .
4. **Digital Signage (Smart Display)** in entire building of Auditorium & Convention Hall only of ROURkela one .
5. **Audio & Video System (AVS)** in main sections of Auditorium & Convention Hall only of ROURkela one .
6. **Wi-Fi Hot Spot (Wi-Fi)** in entire building of Auditorium & Convention Hall of ROURkela one .

Exclusions:

PAN City solutions and system integrations in Integrated Command & Control Centre (ICCC) & Data Centre (DC) will be carried out by MSI (Master System Integrator) Vendor. All work related to ICT in ICCC Building on 2nd floor and 3rd floor will be taken care by MSI Vendor. Work awarded vendor has to coordinate with MSI Vendor (PAN City) for ICT related work at ICCC building.

1.2.5.1 Fire Detection & Alarm System (FDAS)

Scope of work considerations include, but not limited to:

A. The FDAS shall form a network to monitor the entire **Auditorium & Convention Hall** including the entire **Basement** and its surrounding also monitor the status of entire **ICCC Building** (Where-as applicable) and **tribal museum building**.

B. All controls and panel monitoring will be controlled from and in the LV/ICT Room in the Auditorium & Convention Hall and as well as in ICCC Building at both locations.

C. Additionally a repeater fire alarm panel/ monitor shall be provided at the security block near main gates in both buildings.

Codes and Standards

All equipment, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment shall be installed. The FDAS system shall comply with NFPA 72 & IS 2189 (2008) for all application.

In particular, the following standards are applicable

BIS :	Bureau of Indian Standards (IS:2189)
NFPA:	National Fire Protection Association
IEC :	International Electro technical Commission
NEC:	National Electric Code
NEMA:	National Electrical Manufacturer's Association
NBC:	National Building Code

Other national standards established to be equivalent or superior to the codes and standards specified are also acceptable.

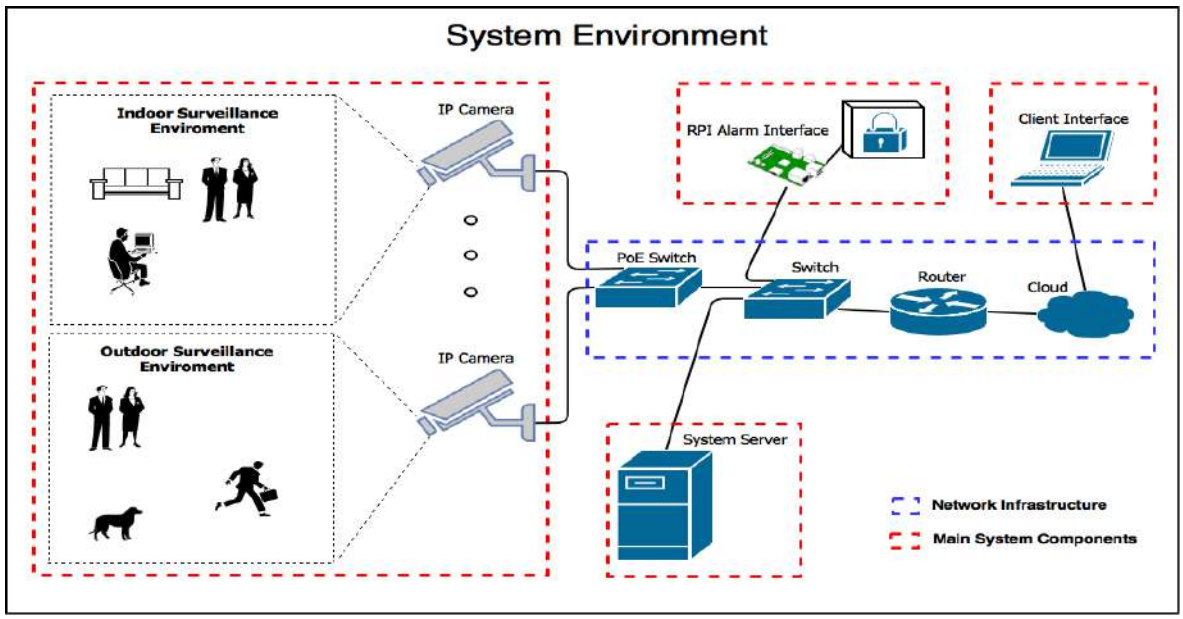
Unless indicated otherwise, all codes and standards referred to in this enquiry specification shall be understood to be the latest version on the date of offer made by the Bidder.

Mandatory Approvals

- UL/ VdS listing
- FM approval

1.2.5.2 Closed Circuit Television (CCTV) Camera

An indicative solution architecture proposed for the installation of CCTV Surveillance System at **ROURkela one – Auditorium & Convention Hall Building** and **ICCC Building** to enhance monitoring and management of security incidents in the building area is presented in the figure below:



As highlighted in the figure above the network comprises of network of CCTV cameras, which are connected to Network Video Recorder (NVR)/**Storage Servers** which stores and converts the video input as per the output requirement. The converted video feed is relayed to the monitoring station at campus, which is monitored by operators. On the event of detection of an incidence or possible cause of event, an alert is generated. Based upon the nature of alert the operator informs the concerned department for their timely response and resolve of the incident.

Video footage of ICCC and Auditorium & Convention Hall will be monitored and stored at a single location in ICCC building. For this it is recommended to use storage server at ICCC building and one extended client monitoring will be provided at Auditorium & Convention Hall building.

Scope of Work - CCTV

The broad scope of work to be covered under this sub module shall include the following, but is not limited to:

- To design, supply, and install the surveillance cameras as defined in attached drawing; all cabling & connections for the system shall be installed by the System Integrator (SI). The SI shall supply all the necessary equipment for the Video Surveillance operations including camera indoor/outdoor weatherproof housings and mountings, camera poles, network switches, cabling (OFC/Copper/Network), and shall make the final connections. Appropriate junction box shall be provided for housing equipments, network switches, Power supply unit and UPS.

- The SI shall undertake due diligence for selection and placement of surveillance cameras to ensure the optimized coverage of the public gathering places & strategic locations, accuracy of the information captured on the field and for rugged operations.

- The SI shall be responsible for providing the entire necessary IT infrastructure for monitoring, recording, storage & retrieval of the video streams at viewing centers, ICCC or any other location for minimum 30 days backup

- Video footage of CCTV Cameras will be stored in ICCC building for both building Auditorium & Convention Hall Including Basement and ICCC on Storage Server but Client monitoring will provided at both locations.

- SI shall tap power from power network line (it is a common power & backup line for components at ROURkela one at Auditorium & Convention Hall including the entire Basement and ICCC Building).

1.2.5.3 Audio & Video System – For Auditorium Hall Only

Audio & Video System (PA system) is an electronic system comprising video screens, projectors, microphones, amplifiers, loudspeakers, and related equipment. AV System processing both a sound and a visual component, such as slide-tape presentations, films, television programs, church services and live theater productions.

It's made up of several components, and while one system can vary greatly from the next, each one handles these same basic functions:

General Condition

1. The contractor shall supply, install, test, connect and commission a high quality fast Professional Audio System complying strictly with BS 5839 part8 and IEC60849 and shall be EN54, CE, ROHS approved in accordance to the local authority of jurisdiction.

2. The system shall be Decentralized, each Node shall comprise of Distributed Amplifier Unit “DAU” which shall comprise of all the intelligence including but not limited to Master Control “DSP” with in-built messages, Amplifiers, Power Supplies and Music Routers. All these Nodes “DAUs” shall be interlinked via fire rated fiber optic redundant ring network, to comply to EN60849 and BS5839 part.

3. In case of open / damage of the Fiber Optic Link shall not affect the operation of the network, as it shall utilize Redundant Loop Topology. The system shall report fault back to all network nodes indicating which segment of the network has been damaged. The Fault report shall be pin-pointed out on the Graphical User Interface “GUI” as well.

4. The system shall be used for Professional Sound Reproduction for all the areas where possible special events take place, particularly in the Centre and the Four Nodes. It shall be possible to plug-in or inject Music Sources at certain Plates Locations, and from the GUI "Graphical User Interface" shall be able to route the music to any location. It shall be possible to use defined Pre-Sets to route / control music.

5. Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components, acoustic calculation to meet with BS5839 part8 RASTI requirements of 0.5 on the STI scale and 0,7 on the CIS scale as per EN60849.

6. The contractor shall be required to train and instruct client's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project.

7. To ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local System Integrator who will be responsible for the design, global operation, management and interfacing of the system as defined in BS5839 part 1.

8. The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicates less power tapings.

9. The back-ground noise of the projects shall be considered 80dBA. The contactor must endure minimum of 10dB above noise levels are achieved.

The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings

Design Concept

1. The entire system, speakers, equipment shall be manufactured from a single source to assure reliability and continued service.

2. The manufacture/installer shall provide 2 years' warrantee on the system.

3. The entire Voice Evacuation and Public Address System shall be integrated with the Fire Alarm System and shall be sitting on the same Fire Alarm Loop.

4. The GUI "Graphical User Interface" shall be the latest technology in routing music with all the Professional Audio Library Functions of windows drag and drop such as Equalizers, Mixers, Auto Mixers, Fillers, Compressors, Crossovers, Feedback Killer, Gates, and Delays. All these

blocks shall come part of the GUI. The system shall be able to provide the AutoCAD of the building and shall be easily able to drag and drop any of the controls, Mute Buttons, Volume Controls or any other control on the software to enable the user to easily control and route the 48 audio channels to any selected location as per the building map.

5. The system shall be de-centralized in nature, each distributed rack DAU “Nodes” shall have all the DSP, messages, amplifiers, monitoring in such a way that can work in a standalone mode in case the master rack is faulty or down.

6. The DAU shall utilize the latest DSP (Digital Signal Processing) capabilities to perform high quality and site programming flexibility, as well providing high fidelity music over 32 audio channels. Being DSP, the system shall have in-built 7 band PEQ “Parametric Equalization” on each output i.e. speaker outputs, and 3 band PEQ on each input i.e. Mics, Music Audio, Messages as well Delays, Matrix, AGC “Automatic Gain Control”, Message Timing Router, Automatic Level Control. Each Node / DAU must be battery backed up to comply to BS5839 part 8 for 24 hours and 30 minutes of alarm operations.

7. The DAU shall play background / Foreground music and in case of Fire Alarm / Paging announcement, the system shall go to full power as programmed to provide the enough SPL levels to comply with BS5839 part8, with minimum of 10dB above the noise levels.

8. Minimum back ground noise to be considered at 80dBA in this project.

9. All system components shall be digitally monitored including and not limited to, Messages, Amplifiers, and back up amplifiers, Speaker Circuits, Audio Matrix units, Paging Microphone, Battery Charger and the 230VAC line. Each amplifier / line circuit shall be monitored individually and shall report any faults back to the Master Audio Matrix Unit as well as the CFM.

10. The system shall can send messages automatically to any zone at any time interval, without affecting the music in the other areas.

11. Each Zone and circuit speaker shall have separate amplifier, system sharing two amplifiers to multiple circuit speakers are not acceptable.

12. There shall be one back up amplifier for every four amplifiers, the system shall automatically change over to the backup in case of any amplifier failure, and the backup amplifiers shall be monitored as well.

13. The System can provide any Cause & Effect programs after integrating with the Fire Alarm System, thus Alert/Evacuate messages can be programmed and delayed as well as played on any zone / floor as per the Cause & Effect approved by the Engineer.

14. The Battery Backup shall provide 24 hours of back up and 30 min of alarm operation. The power supply / charger must comply with EN54 part 4 and shall be 19" rack mounted. Battery calculation must strictly comply with BS5839 part 8 and shall be based on the amplifier size and not the speaker circuit load.

15. The system shall be properly integrated with the fire alarm system.

16. The integrated system shall cover all normally accessible areas including the car parks. All stair cases shall have dedicated zone riser

17. The system shall be capable of being used for everyday background music and public announcement duties; with the fire alarm initiated emergency announcements overriding all other facilities.

18. Evacuate signal relates to a general evacuation message and alert message corresponds to standby instructions.

19. In addition, a FIRE DRILL, BOMB ALERT, EARTHQUAKE ALERT and an ALL CLEAR message shall be incorporated into the operation.

20. The Entertainment Rack shall be in the Control Room enabling the operator to select music from Music Server.

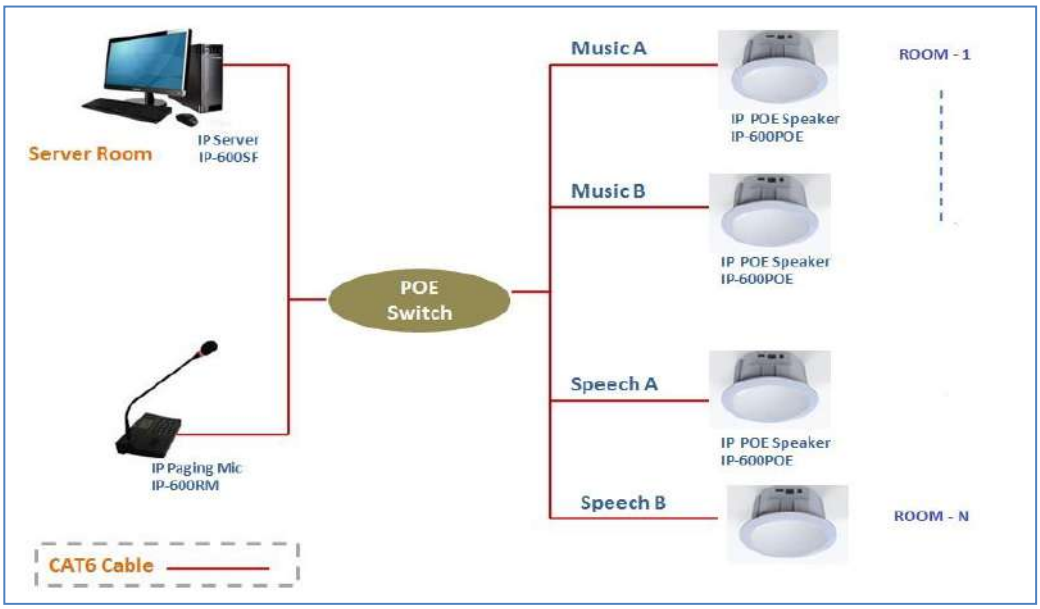
Quality Assurance

Acceptable Manufactures: International Existence and have local representation in India, with a sound track record of installation in the Voice Evacuation and Public Address complying with EN60849 and BS5839 part 8.

1.2.5.4 Public Address System

An indicative solution architecture for the proposed Public Address system to provide real-time information to the inhabitants inside the ROURkela one campus Auditorium & Convention Hall Including Basement and ICCC Building, prevailing important and emergency conditions, if any, on account of public announcement. PA over IP refers to PA paging and intercom systems that use an Internet Protocol (IP) network, instead of a central amplifier, to distribute the audio signal to paging locations across a building or campus, or anywhere else in the reach of the IP network, including the Internet. Network-attached amplifiers and intercom units are used to provide the communication function. At the transmission end, a computer application transmits a digital audio stream via the local area network, using audio from the computer's sound card inputs or from stored audio recordings. At the receiving end, either specialized intercom modules (sometimes known as IP speakers) receive

these network transmissions and reproduce the analog audio signal. These are small, specialized network appliances addressable by an IP address, just like any other computer on the network.



1.2.5.5 Digital Signage

Digital Signage's are a network of electronic displays that are centrally managed and individually addressable for the display of text, animated or video messages for advertising, information, entertainment and merchandising to targeted audiences. The main functions of this signage will be as mentioned below:

1. Event Information's & Timing display
2. Venue details & locations display
3. Any other administrative info display
4. And some commercial advertisement display.

Scope of Work – Digital Signage

- Design, Supply, Installation Testing & Commissioning of Digital Screen (Smart Display) at In Auditorium, Convention Hall Common Pathway and Public Gathering Place at ROURkela one - Auditorium & Convention Hall Building with five (5) years of operations & maintenance.
- Supply, Installation Testing & Commissioning of Scheduler & Designer Software for Digital Screens.

1.2.7 PLUMBING, WATER SUPPLY & SEWERAGE

1.1.1. Scope

This section covers design and execution of internal & external water supply works for all utility buildings, landscaping irrigation, sanitary installations, etc. The brief items of works included are;

a) External Water Supply System includes Underground tank, Tube wells, pumping machineries, electrical works, rising main, distribution system etc.

b) Internal plumbing

c) Sanitary fixtures and accessories.

d) Sewerage system and STP

e) Soil, Waste, and vent pipe system.

f) Rainwater piping system for terrace floor.

g) Landscape irrigation

1.1.2. Design Objectives

1. Minimize water consumption and maximize the water efficiency within Buildings, to reduce the burden on Municipal water supply and wastewater supply.
2. Use of recycle water and dual plumbing systems in each building for use of recycle water.
3. Maintaining self-cleaning and no scouring velocities in the sewer lines and maintains other important parameters as per reference codes and standards.
4. Establish piping network designs to ensure that adequate pressure available at all the user points.

1.1.3. Concept

Over all water supply system is categorized into two types based on the uses i.e domestic and non-domestic. Domestic includes drinking, washing, flushing, bathing etc. and non-domestic includes landscaping irrigation.

Further domestic water categorized as potable and recycle water based on the quality uses. Recycled water will be used for flushing purpose in buildings and landscaping irrigation. Potable water will be used for all other domestic uses.

All potable water supply will be from PHED supply. For flushing and other non-domestic uses treated water will be used from STP. Any shortfall of water will be fulfilled from borewells.

1. For the domestic purpose, It is proposed to use water supplied by PHED which will be collected in underground tank by taking service connection from nearby supply line.
2. For non-domestic uses such as flushing, landscape irrigation treated recycle water will be used. For this required capacity of packaged STP will be provided.
3. Underground water tanks (fire, domestic, treated) will be designed with a partition for maintenance purpose. The material of construction tanks shall be RCC.
4. The potable water first supplied in the fire water tank and overflow of the same shall be transferred to the domestic water tank. From domestic UGT water will be pumped to different overhead tank in each building.
5. Provision of flushing water tank shall be provided to store recycled STP treated water, which will be used for flushing and irrigation purpose. Additionally tube wells are prosed for fulfill the domestic and non domestic requirement incase any shortfall.
6. The water level in the RCC underground and overhead water tanks shall be controlled by a solenoid valve & Float valve installed in the water tank inlet.
7. The sizing of the entire water distribution network is based on the simultaneous use of the fixture unit's demand. Individual toilets will be provided with isolation valve for isolation and maintenance of the system.
8. In basement packaged STP is proposed for collection and treatment of sewage.
9. Dual plumbing system has been considered for use of recycling water for flushing purpose. Terrace rainwater shall be collected through pipes & transferred to rainwater holding/harvesting tank for further use.

1.1.4. Water Demand

S.No	Category	Unit Water Demand				Rourkela One			
		Unit	Total	Potable	Non-Potable	Population/ Area	Total Water Demand (Liters)	Potable Water Demand (Liters)	Flushing Water Demand (Liters)
1	**CCC Building**								
a	Residential Population	LPCD	135	90	45	20	2700	1800	900
b	Commercial Population	LPCD	45	20	25	250	11250	5000	6250
c	Floating Population	LPCD	15	5	10	750	11250	3750	7500
2	**Auditorium & Convention Centre**								
a	Residential Population	LPCD	135	90	45	15	2025	1350	675
b	Commercial Population	LPCD	45	20	25	35	1575	700	875
c	Floating Population	LPCD	15	5	10	3000	45000	15000	30000

3	**Tribal Museum**								
a	Residential Population	LPCD	135	90	45	10	1350	900	450
b	Commercial Population	LPCD	45	20	25	30	1350	600	750
c	Floating Population	LPCD	15	5	10	500	7500	2500	5000
5	**Landscape Area Total Site**	L/sq/d	5		5	14150	70750		70750
	Total Water Requirement						**154750**	**31600**	**123150**

1.1.5. Description of The Works

- Service connection from PHED supply lines for domestic potable water
- Drilling and development of 200mm dia 150m deep tube wells (2 nos) for non domestic and flushing water including installation of submersible pumps of required head and discharge and all required mechanical & electrical works.
- Design and construction of RCC underground water tank for potable, recycle water for minimum half day capacity of daily demand.
- Design, installation of pumps and construction of pumping station including all electrical, mechanical works for pumping water from underground tank to overhead tank for potable and flushing water.
- Laying of pumping network for domestic and non domestic water including required valves, fittings, water meters at inlet and outlet of tanks. For water network DI K9 pipe will be used for size 100mm dia & more and for lesser diameter GI pipe will be used. The network shall be provided with required number of valves, water meters and other accessories as directed by employer.
- Construction of necessary thrust block, anchor block, saddle support, encasement. Thrust block shall be designed for the test pressure which is 1.5 times of maximum working pressure.
- Complete internal plumbing and sanitary installation for dual water supply including provisioning of twin overhead storage tank for potable and recycle water supply.
- Construction of 61 kld STP

- Sewer network from all the buildings including construction of collection chamber and connection to the proposed STP inside the premises as well as by pass arrangement to connect with public sewer network.

1.1.6. List of Indian Standard

All services being planned generally in conformity with the requirement/recommendation contained in the following Indian standards (BIS)

a) National Building Code - 2016

b) SP: 35: Hand Book on Water Supply & Drainage

c) UPC – Uniform Plumbing Code

d) CPHEEO – Manual on Water Supply and Treatment

e) CPHEEO – Manual on Sewer and Sewage Treatment

IS 1172: 1993 – Code of basic requirements for water supply, drainage and sanitation.

1.1.7. Domestic Water Supply System

Water from municipal water supply main for the domestic purpose will be stored in an RCC water storage tank. The water meter will be installed externally near water tank before the inlet of the underground water tank. To fulfil shortfall of domestic water demand, bore well will be used.

Gravity system will be considered to distribute domestic water from overhead tank. Water shall be pumped from Centralized underground tank to the Overhead tank.

Electronic sensor based water level indicator will be considered in the design for water tanks to monitor the water level in the tanks. The sizing of the ring main and vertical piping shall be based on the simultaneous demand of fixture units. Domestic water supply system and pipe sizing will be designed considering sanitary wares and fixtures selected and approved by the Client.

1.1.8. Recycled Water Supply System

Treated tertiary water from STP will be used for flushing & irrigation and will be stored in a separate underground tank. Recycled water from underground tank will be supplied to roof water tank and further distribution by gravity to the entire floor via vertical stacks. The water distribution system will have vertical pipes from the ring main on the roof for each shaft.

Booster pump set will be provided for irrigation purpose. The water meter will be installed on delivery line of STP treated water before the water is stored in recycled water tank. Electronic sensor based water level indicator will be provided for water tanks to monitor the water level in the tanks.

The sizing of the ring main and vertical piping shall be based on the simultaneous demand of fixture units and will be designed by the contractor.

At present for flushing and irrigation tube well water will be used.

1.1.9. Irrigation Water Supply System

For irrigation water treated recycled water will be used. Provision of bore wells will be kept for fulfilling the shortfall in water. Irrigation pumping system will be designed to pump irrigation water for four hours a day.

Drip irrigation system and sprinkler irrigation system depending on the plant type as per approved design. The system shall be fitted with timer-based solenoid/control valve for an automatic system.

1.1.10. Internal Plumbing

Internal plumbing shall be designed according to National Building code of India.

1.1.11. Internal Soil and Wastewater Drainage System

Soil and waste water drainage system from the building is designed as dual stack system (soil and waste stack separately). The vent pipe is designed for soil vertical stack only. Vent vertical stack is connected to soil line at each floor to protect water seal of European water closet against siphoning. Each shaft will have independent soil and waste vertical stack.

The waste generated from the pantry, utility, etc., shall be collected through a separate vertical pipe waste stack. The waste stack shall be extended minimum 750mm above the terrace parapet level as a waste vent through the roof. Sewage from the water closets and urinals shall be connected through a soil stack. The soil stack shall be extended minimum 1200mm above the terrace parapet level as a soil vent and fitted with vent cowl.

The minimum outside diameter of the 110 mm for vertical soil and 82 mm for waste stack will be designed. Diameter will vary as per the design flow and load. The soil stack shall be directly connected to the inspection chamber. The waste stack shall be connected to the inspection chamber through a gully trap. The gully trap shall have deep water seal, which will prevent foul gases and the entry of cockroaches into the toilet area. The spacing of the inspection chambers shall be kept to a maximum of 15 - 18mtrs.

The sewerage network comprises series of inspection chambers/manholes with varying invert level with interconnecting pipes. The minimum diameter of the external sewer network will be 200mm and the maximum diameter will vary as per the design flow. The drop manholes shall be

constructed at places where the depth of drop exceeds 600mm from building sewer to the main sewer. It is ensured that the flow from building a sewer to the main sewer shall be smooth and free from noise.

Internal soil and waste pipes for toilet blocks will be designed within the sunken portion. Floor cleanout will be provided as per design for ease of maintenance. Toilet sunk of 250 to 350 mm is considered to fulfil minimum slope requirement of soil and wastewater drainage piping in sunken portion. Deep seal P traps shall be provided for Floor drains and Urinal traps. All fixtures and appliances shall be fully trapped to prevent backflow of foul gases and odour into the toilets.

Sewers are designed to carry wastewater along with the suspended solids in such a manner that deposition and odour nuisance is kept to a minimum. Sewers are also designed for self-cleansing velocities. The pipe design at the change in the direction of flow shall be designed in such a way that the hydraulic jump phenomenon will not occur.

1.1.12. Design Criteria

Under ground water tank

The storage capacity of underground ugt is proposed for 12 Hours capacity which shall be constructed in RCC with RCC roof. Water from this tank shall be pumped to the individual over head tank in each building This tank shall have two compartments from the point of view of O & M. Necessary appurtenances such as inlet, outlet, overflow, vent pipes etc shall be provided.

Domestic Water Pump House (Potable & Recycle)

The domestic water pump house shall be provided adjacent the reservoir. The pumps shall be horizontal split casing centrifugal type and with 50% standby. The pumping shall be considered for 4-6 hrs working per day. Power supply arrangement shall be made for the pump house. Automation shall be provided for operation of pumps. Bulk flow meters shall be provided on clear water transmission mains for recording quantum of water supplied.

Criteria adopted in the design of Pumping Station for water supply are as follows: -

i. Velocity in suction and delivery pipes shall be restricted to 1.5 m/s to 2.5 m/s respectively.
ii. Velocity in pumping main range from 0.6 m/sec (minimum) to 2.5 m/sec (maximum).
iii. Hazen William`s Coefficient will be considered as 130 for DI pipe.
iv. Safe working load of lifting equipment will be at least 50% higher than maximum weight required to be handled at the pumping station.
v. The preferred range of specific speed shall be 3000 to 4000 USCU.

vi. Type of pumps shall be horizontal split case.

vii. Hours of operation for pumps shall be 6.

viii. Design head shall include static head, friction loss in suction, delivery and rising main and head loss in valves and fittings.

ix. The sizes of valves shall be same as size of individual pipes.

Rising Main

- Minimum Residual Pressure above FSL of ESR – 2.0m
- Pumping hours –4 to 6 hours as per requirement and approved by employer.
- Design Velocity – 0.6m/s to 1.50m/s
- Maximum Unit head loss – 6m/km

Pipe Material

- Plumbing – CPVC
- Pumping lines - DI for 100mm & above, GI for below 100mm
- Landscaping irrigation – Header pipe: CPVC, branch pipe - HDPE

Class of pipe shall be commensurate to the maximum pressure in the system.

The Pipe line should be designed in conformity with CPHEEO Manual and relevant IS codes

Tube Well

Scope under this works include broadly as follows:

- Hydrogeological investigation
- Drilling of bore well. The size and depth of bore well be shall be so decided that, the safe yield of all bore wells shall meet the demand of non-domestic demand.
- Yield test, draw dawn test
- Construction of pump house at each bore well
- Installation of submersible pumps of required capacity and head to discharge water from bore wells to different points.
- All Electrical works
- Designing and laying of rising main from bore wells to different units.

The above works are for reference purpose, the contractor shall have to execute all the works as required by employer to complete the work in all respect.

Design specifications

- Type of drilling method – As per nature of formation below the ground the best suitable drilling methods are either Direct or Reverce rotary method, with drilling diameter of minimum 20”/18”.
- As per expected presence of good quality of groundwater the casing assembly of PVC casing pipe (Schedule-80) (8” Diameter) plain & strainer pipes may be lowered in the tubewell.
- The annular space between wall of the bore & casing assembly, should be filled by well sorted “Pea Gravel”.

- The development of tubewell to be recommended first by high capacity air compressor (Min. 300 cfm / 150 psi as per IS - 2800 part II) followed by an over pumping unit.
- Additonal gravel should be filled, after completion of development.
- The tubewell shall be sealed at top, by Cement sealing, preferably upto 1 m depth, to prevent percolation of surface run-off in the tubewell.
- The litho-logs obtained from the tubewell to be collected & preserved at every 3 m interval for further study & record.
- The submersible pump set related to expected discharge, water level, drawdown & total head, to be recommended for installation in the tubewell.
- The tubewell should be plugged at bottom by “bail plug” & at top by “well cap”.
- The pump set should be of approved make, confirming to IS specifications, suitable for 415 volts, 3 phase, 50 cycles AC supply, having delivery outlet, suitable for connecting 100 mm outer diameter GI pipe.
- The pump set shall be lowered by 100 mm outer diameter, threaded GI pipes, which shall be connected by sockets. Flat MS flanges may be applied at joints for additional support.
- A steel rope may also be used for connection of pump, along with GI pipes, for additional support.

Storage Tanks

- Common underground Tank – One day storage capacity
- Material of construction - RCC
- Individual Overhead Tank- 12 hours storage capacity of daily demand.
- Material of construction – PVC tank up to 2000 ltr capacity and RCC for more than 2000 ltr capacity.

Self Cleansing Velocity

Self-cleansing velocity is determined by considering the particle size and specific weight of suspended solids in sewers. The velocity of 0.60 m/sec to 1.2 m/sec at design peak flow is considered.

Erosion and Maximum Velocity

To avoid erosion caused by excessive velocity and presence of sand and gritty materials in the sewer. The system is designed in such a way that velocity in sewer shall not exceed 2.4 m/sec.

Plumbing Fixtures

a) Plumbing Fixtures, Chrome Fittings, and Accessories shall be of the best available Indian maker selected in consultation with Architect and Client. All sanitary wares shall be best quality vitreous china of desired color and brand.

b) Water Closet: Wall Hung type EWC’s shall be provided with a Flush valve.

c) Ablution: C.P. hand shower/health spray with lever operation is also been proposed in place of ablution tap. This will be connected to an angle valve.

d) Washbasin: Counter wash basin (as per the architectural details) shall be provided with a C.P. Pillar tap in toilets.

e) Urinal: Urinal as per the architectural details is shown in layout shall be provided.

Soil, Waste & Vent pipe system

a) Soil and waste water drainage system from the building is designed as dual stack system (soil and waste stack separately).

b) The vent pipe is designed for soil vertical stack only. All vertical pipes will be terminated as vent pipe at terrace level. The waste stack shall be extended minimum 850mm above the terrace level as a waste vent through the roof. The soil stack shall be extended minimum 1200mm above the terrace level as a soil vent and fitted with vent cowl.

c) The size of vertical stacks will be not less than 110 mm dia for soil stack, 110 mm diameter for the waste stack, and 75 mm dia for vent stack.

d) uPVC type B (SWR) pipes and fittings with rubber ring joints is being proposed for soil, waste, vent disposal for all floors.

e) All ground floor toilets/waste appliances shall be connected to the Manholes directly. Gully traps have been proposed for waste connections.

f) All toilets are proposed to be sunken by 450mm and internal Soil & Waste pipes area designed to run in the sunken area.

Pipework

a) All stacks shall be installed in shafts on the external face of the buildings or in internal shafts within the building as per the architectural planning of the toilet.

b) It is proposed to provide suitable access to pipe shafts from with-in the toilets or from outside for maintenance as per the architectural plans and feasibility.

c) The provision includes providing clean-out doors and plugs for maintenance where necessary and required.

d) Deep seal P traps shall be provided for floor drains and urinal traps. All fixtures and appliances shall be fully trapped to prevent backflow of foul gases and odour into the toilets.

e) Self-cleansing velocity is determined by considering the particle size and specific weight of suspended solids in sewers. The velocity of 0.75 m/ sec to 1.2 m/ sec at design peak flow is considered.

f) To avoid erosion caused by excessive velocity and presence of sand and gritty materials in the sewer. The system is designed in such a way that velocity in sewer shall not exceed 2.4 m/sec.

DESIGN CRITERIA FOR SPRINKLER IRRIGATION

- Type- Fixed Solid Set
- Design Pressure – 24m to 35m
- Sprinkler spacing – Half of waited diameter
- Supply hours- Four hours

DESIGN CRITERIA FOR SEWER COLLECTION NETWORK

- Peak factors shall be considered based on contributory population to arrive at the peak flows as per CPHEEO manual.
- Design formula: Manning's formula
- System design: Gravity system
- Coefficient of Roughness: as prescribed in CPHEEO manual,1993 / 2013.
- Pipe Material: RCC of NP2 for diameter upto 300mm and NP3 for above 300mm per IS 458.
- Bedding for Sewers: as per the relevant standards.
- Minimum size of sewers: 200mm
- Design capacity of sewers: 80 % at ultimate peak flow
- Self cleansing velocities: Minimum velocity : 0.6 m/s (present peak flows)
  : 0.8m/s (design peak flows)
- Maximum velocity: 2.5m/s
- As per relevant CPHEEO guidelines
- Depth of cover: The minimum depth of cover at sewers start is 1.0 meters
- Per capita sewage generation shall be 80% of domestic supply.
- In the hydraulic design of sewers, an allowance for infiltration for the project area shall be considered as per CPHEEO Manual, Nov 2013
- Peak factor for sewerage system shall be based on contributing population for domestic sewage as per CPHEEO sewerage manual, 2013.
- Manning's formula shall be adopted for design of gravity sewers with coefficient of roughness as specified in CPHEEO manual.

Sr. No.	Design Parameters	Value
1.	Ground water infiltration	500 ltr/day/manhole
2.	Peak Factor	3
3.	Capacity of conduits	80% full at peak flow
4.	Minimum velocity	0.6 m/s – minimum velocity at initial peak flow

		0.8 m/sec –peak flow
5.	Depth of cover	1.2 m Minimum depth of cover will be provided over top of pipe at the start of the sewers.
6.	Bedding for Sewers	Bedding Factor — Type of Bedding Up to 1.9 — Granular 1.9 -2.8 — Concrete Cradle Bedding with Carefully compacted backfill (PCCB) 2.8-3.4 — Reinforced concrete cradle (RCCB) > 3.4 — Reinforced concrete encasement (RCE)
7.	Manholes	@ 30 m c/c distance and at junctions
8.	Pipe Material	RCC- NP3 class

Manhole

- Brick Masonry manholes for depths up to 2.3m and RCC manholes for higher depth .
- The manhole frame and cover proposed shall be of Steel Fibre Reinforced Concrete (SFRC) conforming to the relevant IS codes.
- Sizes of Manhole is as per relevant IS codes.

1.1.13. SEWAGE TREATMENT PLANT

PLANT CAPACITY

Package Sewage Treatment Plant (PSTP): - 61 KLD capacity. Since the flow is predominantly from office complex, hence the peak hours are considered as 8 hours which is 10 am to 6 PM. In remaining period nominal flow will be generated.

A PSTP of 61 KLD capacity is planned which will cater the sewage generated Command Control Centre, Auditorium & Convention Centre and Tribal museum.

CHARACTERISTICS OF RAW WATER

Sl. No.	Parameter	Values
1	pH	6.5 - 8.5
2	BOD5 @ 20°C, mg/L	250 – 300
3	COD	400 – 500

Sl. No.	Parameter	Values
4	Total suspended solids, mg/L	300 - 400
5	Oil and grease, mg/L	10 - 20
6	Total kjeldahl Nitrogen (as N), mg/L	40 - 50
7	Total Phosphorus, mg/L	5 - 7
8	Faecal Coliforms MPN/100 ml	10^6 to10^8

CHARACTERISTICS OF TREATED WATER

It is proposed that the sewage which is generated is to be treated to such standards that it can be used for flushing, landscape irrigation and gardening.

Treated water from tertiary treatment of STP is proposed to be stored in a separate treated water tank near STP. This treated/ recycled water is proposed to be supplied for flushing, landscape & irrigation.

Hence, expected standard will be as given in table below:

Treated Sewage Standards

Maximum limits/Type of	Unit	Desired Values
Colour	-	Acceptable
BOD	mg/lit	≤ 10
COD	mg/lit	≤ 50
Residual Chlorine	mg/lit	1
Faecal Coliform	mg/lit	No detectable Faecal Coliform
pH		6.5-8.5
TSS	mg/lit	≤ 10

[#] Residual chlorine for flushing water need not be >1.

***** From Practical Consideration

SCOPE OF WORK

General

The scope includes design, engineering, manufacture, supply, installation, testing and commissioning and operation of the package STP system of 61 KLD. The scope of work includes all civil, mechanical and bought-out equipment, piping, electrical and instrumentation work.

Testing and Commissioning

All equipment and components of the STP shall be tested for the performance as per the duty points and specifications. Also the untreated and treated wastewater quality shall be tested at various stages

for polluting parameters to ascertain that the STP meets the stage-wise and overall desired treatment requirements. The Contractor and consultant shall prepare a schedule of such stage-wise testing.

The Contractor shall maintain a record of all such testing carried out duly signed by Contractor, Employer and consultant

Operation Services

After commissioning, the contractor shall operate the STP for a period of 60 months under his control for stabilization and to demonstrate the results. The Employer shall provide the operating manpower and consumables for this.

Drawing and Documentation

- Technical Approval Stage : Detailed hydraulic Design, P & I diagram, General Layout, Hydraulic Flow diagram, data sheets of mechanical equipment, performance curves and catalogues for offered components.
- Execution Stage : In addition to final approved drawings of bid stage; GA drawings for all civil work, foundation drawings, piping and electrical layout, Electrical Scheme diagram etc. as applicable shall be submitted to employer for approval prior to fabrication/ ordering.
- Post Completion Stage : The contractor will submit all as built drawings, trial runs and commissioning report and operation and maintenance manual in three sets in required format, as final documentation on completion of the STP.

Location

Presently the STP is proposed in basement below Command & Control Centre. Area of 10m x 20m has been provisioned for it. Contractor will have the option of relation of this STP based on the functional requirement, O&M with approval of employer.

Brief Scope of Work

The scope of the work shall include but not be limited to the following:

- Design and manufacture, supply, testing at manufacturers' works, storage when required, delivery to site, unloading and site transportation, erection & commissioning, site testing, painting and finishing of the Plant of capacity 61 KLD
- Preparation of process, hydraulic, civil, electrical, mechanical and piping design. Preparation all civil, mechanical, electrical and piping drawings including architectural, construction and as built drawings.
- Supply, erection testing & commissioning of all the electromechanical mechanical equipment, electrical units, instrumentation and interconnecting piping as per mechanical specifications.
- Drain with valve and pipe arrangement (min 200 mm dia) to all treatment plant necessary units.
- All drains shall be connected to the sump.
- Performance Run of the constructed & hydraulically tested plant along with O & M of electrical & mechanical equipment for a period of Three (3) months and operation

& maintenance for 60 months after performance run as per tender specifications including providing and installing all units, labour, tools and plants all complete on turnkey basis

- Supply of all documentation for the plant such as As-Built drawings, Operation & Maintenance manuals (6 sets)
- Supply of all spares required during performance run and during O & M period.
- Oil painting with anti corrosive treatment for package unit, railing and all MS, CI and GI works.
- Bidders are advised to consult specialized STP vendor to visit site before quoting for the proposed STP in case the STP location is planned in basement.
- Any other items of work which have not been specifically mentioned in the specifications but are necessary for construction of the plant as per good engineering practice and safety norms and operation and guaranteed performance of the entire plant shall be deemed to be included within the scope of work of this specifications and shall be provided by the contractor without any extra cost to the employer.

Details of Maintenance to be carried out

i) The Contractor shall operate and maintain the entire plant within its Contract price for a total operation and maintenance period of 5 years after successful Installation, commissioning of the Plant.

ii) All necessary repairs, maintenance, overhaul, replacements etc., shall be made during the O & M to maintain the plant at the status of formal handling over after the P G test. Contractor shall be responsible for comprehensive repair, break down repair for operation and maintenance during this 5 years period of O&M.

iii) During O & M, cost of power consumed shall be in the Contractor price and bills of electric power shall be paid as per actual consumption as per the figures guaranteed.

The scope shall but not limited to the following items:

- Operation and Maintenance including Electrical, Mechanical and Instrumentation all allied works.
- Sampling and testing of Raw Water
- Sampling of treated Water to ensure that the guarantee Parameters are as stipulated in the design criteria.

Maintenance of log books of all the equipments/instruments various readings of process parameters, record of failures and alarms and shall be forwarded at monthly intervals.

The O & M shall include the appropriate preventive maintenance of equipment as per the Manufacturer's recommendation.

- All the equipment even standby supplied, installed and commissioned by the Contractor should be in operational/ functional condition throughout the O & M period. The Contractor shall take all preventive measures to maintain them in working condition.
- The frequency of break downs of various equipment's shall be the least as far as possible. The total number of such re-occurrences shall not exceed three times per annum otherwise penalty shall be levied on the Contractor at the discretion of Engineer-in-charge.

Mechanical, Electrical & Instruments

1) Preventive maintenance of all the Equipments and Machineries for waste water treatment plant including Pumps, Piping, Valves, equipments, Motors, HT and LT Panels, Transformers, Cables, PLC, Field Instruments, Laboratory Instruments etc. and as directed by Engineer-in-Charge.
2) Breakdown maintenance of all the Equipments and Machineries as indicated above and as directed by Engineer-in-Charge.
3) Calibration of all necessary Field Instruments.

PROCESS DESCRIPTION AND DESIGN CRITERIA

Package STP Unit

Package STP is a combination unit employed for sequential treatment of biodegradation, clarification and storage consisting of Aerobic bioreactor (oxygenated system) and plate settler. It has a hopper- bottomed geometry for thickening the separated sludge. The subsequent unit is a compartmentalized Treated Water tank, which stores treated sewage and is further pumped to tertiary system for purification.

The unit is provided with return biological sludge system for maintaining the desired microbial concentration in the oxygenated chamber.

Dewatered Sludge Quality Requirements

The dewatered sludge quality requirements to be met are listed below:

Treated Sludge Quality Requirements (Dewatered Sludge)		
Parameter	**Units**	**For each STP**
Minimum sludge TSS (dry solids)	% w/w	20%

Treatment Process

- **The contractor shall have the option of suggesting the treatment process based on advanced technology, less area requirement, less O & M inconformity with the above treated water quality parameter**.
- Contractor shall submit the design basis along with detailed comparative statement of available treatment process to the employer and after approval of employer a process contractor shall submit the detailed design for approval.

The treatment technology should also include sludge treatment and its safe disposal. Contractor shall provide a complete, fully functional facility designed for proper, easy, operation and to meet the stated performance requirements. This shall include any and all additional, ancillary, supporting, or other processes, components, equipment, or other items necessary to achieve these objectives, regardless of whether such items are explicitly listed in these bid documents or not.

The design/sizing criteria, minimum number of units, and other requirements for the various unit processes and components are listed below.

Minimum Number of Units or Modules to be Provided for Unit Process		
Unit Process	STP Design Average Capacity (MLD)	
	Number of Units (W=Working S=Standby)	
	W	S
Mechanical Screens	1	0
Manual Screens	0	1
Grit Removal (Mechanical)	2	0
Parshall Flume	1	0
Aeration/Biological Process	2	0
Chlorination with baffle	1 (Two compartments)	0
Gravity Thickening	1	0
Sludge Dewatering	1	1
Plant Specific units depending on the Process proposed in this Bid		
Primary Clarification	2	0
Anaerobic tank	2	0
Anoxic Tank	2	0
Secondary Clarification	2	0
Primary Sludge Pumping	1	1
RAS/WAS Pumping	1	1
Flash Mixing Tank	1	0
Flocculation Chamber	1	0

Clarifier or Clariflocculator	1	0
Sand Filters and other units	As per CPHEEO	
Other tertiary Treatment Unit	As per design	

PROCESS AND FACILITY DESCRIPTION

This Process and Facilities description is intended to provide a general indication of the various unit processes and type of facilities that the Contractor shall be required to design, construct, and operate, and applies to all STP in this contract unless specifically indicated otherwise. The Contractor shall use this description together with other specific information for each STP provided elsewhere in these bid documents, including but not limited all of which are integral to this Process and Facilities Description and are incorporated herein by reference.

The Bidder shall submit plant layout, process calculations, hydraulic calculations, hydraulic flow diagram, P&ID, mass balance calculations, electrical load list etc. along with technical bid for his proposed technology to illustrate the offer submitted with all technical details .

Receiving Chamber:

Gravity Sewer will discharge raw sewage into Receiving Chamber from where it shall be taken into downstream Coarse Screens. The function of the Receiving Chamber is to reduce the incoming velocity.

Coarse Screening

Adequate Nos. of Mechanical/ Manual Coarse Screens shall be provided upstream of Wet Well for removal of floating and oversized material coming with the sewage. The Coarse Screens shall screen out most of the medium & large floating and oversized material such as plastic rags, debris, weeds, paper, cloth, rags etc which could clog the waste water pump impellers. The Coarse Screens shall be inclined Bar Screen of stainless steel flats and shall be of sturdy design to take care of all sorts of materials envisaged in the gravity sewer. The screening material as collected will drop into a wheelbarrow for its disposal.

raw sewage collection tank/ equalization tank:

Screened sewage after Coarse Screening shall enter into raw sewage collection tank/equalization tank. The capacity of the tank is such that adequate detention time is available during average and peak flow conditions. The effective liquid volume shall be provided below the invert level of the incoming sewer after leaving provision for freeboard. Also an additional depression shall be provided to ensure adequate submergence of Pumps. Pumping Station shall have a Room adequate for installing Electrical Panels. Suitable arrangement shall be provided for lifting of Pumps. Suitable combination of Submersible Pumps shall be provided to cater the pumping requirements at average and peak flow conditions. Based on incoming flow conditions, adequate nos. of Pumps shall start / stop automatically to cater the pumping requirements.

Raw Sewage transfer Pumps

The screened sewage will then enter into wet well of pumping station. The pumping station shall be wet well type with submersible non clog type pumps. The capacity of the Wet Well should be kept such that adequate detention time is available during average and peak flow conditions.

Suitable combination of centrifugal pumps shall be provided in the sump as per CPHEEO Manual 2013 edition chapter 4, to cater to the pumping requirements at average & peak flow conditions. Based on incoming flow conditions, adequate no. of pumps shall operate automatically to cater the pumping requirements.

The wet well shall be provided with adequate slope towards suction pit of pump from all sides of wet well to prevent / minimize settling on wet well floor and draw all particles / grit towards the suction pit of raw sewage pumps.

Suitable number of de-silting pumps shall be provided as per design calculations along with required length of cable, starter panel & other required accessories suitable to handle silt/grit/sludge settled in wet well. The sewage from the pump house to STP shall be taken through a Dl K-9 Class pipeline of suitable dia designed for Peak flow. The rising main shall be designed separately for the maximum combined discharge of the pumps. An electromagnetic flow meter shall be installed in the rising main for measurement of flow. The pipeline shall be adequately designed to have a minimum velocity of at least 1.2 m/s at minimum flow conditions and not more than 2.5 m/sec at pumped peak flow. The pump head shall be adequately sized to give a residual discharge head as per CPHEEO manual.

This is component is required in case the hydraulic gradient does not permit gravity flow.

PRIMARY TREATMENT UNITS

Inlet Chamber

Pumped sewage shall be provided at the STP location. The Contractor for this contract shall connect the incoming line to the inlet chamber of the STP, construct the inlet chamber and coordinate the exact location of such chamber with client. The Contractor shall be fully responsible for proper coordination to ensure proper alignments and interfaces and for proper implementation of all connections.

Fine Screens

The fine Screens shall receive sewage from the upstream inlet chamber. The screenings removed by the screens shall be discharged at the appropriate elevation above ground on to a conveyor. A belt conveyor positioned above ground level shall convey the screenings through a galvanized steel chute to a trolley positioned at ground level.

Grit Basins and Grit Washers and Classifiers

A complete grit removal facility shall be provided, with integrated fats, oil, and grease (FOG) removal. All equipment and components (including but not limited to conveyors, pumps, and blowers) necessary for a fully functional system shall be provided regardless of whether or not such items are specifically listed or described in the bid document. Dewatered grit shall be collected in a trolley positioned at ground level below the Grit Classifier discharge. De-gritted sewage shall exit the Grit Basins over the outlet weir. Liquid streams from grit washers and classifiers shall be returned to the de-gritted sewage stream or to the Plant Drain Pump Station. Any FOG skimming's removed shall be routed to the sludge storage tanks or safely disposed off. Each Mechanism shall be provided with Organic return pumps. This shall be suitably located to return organics back to Grit Chamber. The de-gritted sewage shall flow through open channels from the grit separators and confluence into a single channel of suitable width for provision of Parshall flume. Bypass facility for degritted sewage shall be provided. Separate land for grit conveyance shall be indicated in the layout.

Secondary Treatment Units

Secondary treatment processes included but not limited to the following options shall be considered for organic removal along with Biological Nutrient Removal (BNR) to achieve the treated sewage quality specified in section 2.6.

1. Modified Activated Sludge Process (MASP)
2. A2O Process (without coagulant dosing system)
3. Bardenpho 4-stage Process (with coagulant dosing)
4. Bardenpho 5-stage Process (without coagulant dosing)
5. Modified Ludzack Ettinger (MLE) Process (with coagulant dosing system)
6. Sequential Batch Reactor (SBR) (optional coagulant dosing system)
7. Moving Bed Bio-reactor (MBBR) (with pre-anoxic tank and additional coagulant dosing system)
8. Membrane Bio-reactor (MBR) (with coagulant dosing system)

Please note that multi-stacking of units on one another, in any treatment technology, shall not be acceptable.

Primary Clarifiers

Primary Clarifiers shall be provided wherever ASP process is proposed by the bidder, for removal of suspended solids from fine-screened and de-gritted sewage.

Primary Sludge Pump Station

The primary sludge sump shall receive the sludge from primary clarifier by gravity. The primary sludge pumps (Minimum 1W+1S) shall pump the sewage to gravity sludge thickener.

Anaerobic Tank

Sewage from Primary Clarifier shall flow by gravity into Anaerobic Tanks through a channel and distributed by a distribution chamber. Anaerobic tank shall be designed for biological phosphorus removal as per the tender specifications.

Anoxic Tank

Sewage from Anaerobic Tank shall flow by gravity into Anoxic Tank via appropriate isolation gates. Anoxic Tank shall be designed for biological nitrogen removal as per the tender specifications.

Aeration Basin Influent Channel

Influent after fine screen and Grit chamber shall flow by gravity to the Aeration Basin Influent Channel from where it shall be distributed to the aeration basins. Appropriate isolation gates and/or valves shall be provided to allow isolation of each basin. A bypass mechanism shall be designed and constructed such that channel contents will be bypassed around the aeration basins only if inflow to the channel exceeds the combined peak hydraulic design capacity of all aeration basins in service. The bypass flow shall be routed to the receiving water body via the plant outfall pipe.

Aeration Basins

The top-of-wall of aeration basins weir elevation shall be such that system should work on a gravity influent condition. No Equalization Tanks or flash filling are acceptable.

For nutrient removal, coagulant dosing system for phosphorus removal and/ or tertiary treatment by filtration shall have to be opted, wherever applicable.

Each aerobic basin shall have a separate diffuser grid supplied by a separate air drop pipe with the air flow controlled by a separate valve and measured by a separate flow meter. All systems shall use Dissolved Oxygen with VFD driven Blower. Stub walls shall be incorporated into the structural design of the aeration basins to allow easy addition of the extra partition wall in the future if needed. The RAS piping/channelling shall also be designed such that potential future piping and valve modifications necessary to match the potential future zone modifications described above can be accomplished with ease and minimal disruption. Mechanical surface aerators are not acceptable. In case of any other type of Aeration Equipment one total set of the equipment should be provided as standby. Diffused aeration shall be of retrievable type.

The aeration shall be provided primarily for biological treatment. The aeration equipment shall also to provide adequate mixing arrangement in the aeration tank to keep the solids in suspension. For diffused aeration, the air volume for mixing shall be not less than 1.8-2.7 $m^3/hr/m^2$ of floor area.

SBR Basins

SBR process shall be designed to treat peak flow sewage for organic load reduction along with built-in nitrification-denitrification and biological phosphorus removal. SBR designs shall strictly comply with the minimum sizing and all other requirements specified in the bid documents. Process air blowers as well as air piping and valves for SBRs shall be configured such that one or more blowers are dedicated to each SBR basin that is in the aeration phase at any given time. The discharge from any given blower shall be routed to no more than a single SBR basin at any given time. In case of any other type of Aeration Equipment one total set of the equipment should be provided as standby.

For SBR process, the recirculation of activated sludge (RAS) may or may not be provided depending upon bidder's design/proposal.

No. of WAS (waste activated sludge) pumps shall be minimum 1W+1S for each basin.

MBR Basins

For STPs with MBRs shall be designed to treat peak flow sewage for organic load reduction along with BNR, the Aeration Basin shall house the membrane filtration modules. The MBR basins shall be fully covered with solid non-skid GRP cover plates. The design shall provide for easy isolation of each MBR basin and shall include all required facilities for complete, fully automated clean-in-place (CIP) functionality. An electric overhead bridge crane shall be provided for easy removal of the membrane modules. The crane shall provide adequate vertical clearance to safely lift the membrane modules above all piping, equipment, or other items that may be located in the travel path from the module location in the tank to an adequately-sized adjacent membrane "lay-down" area designated for membrane maintenance. The crane coverage shall include the entire MBR basin area plus the lay-down area.

The sludge from MBR basins shall continuously overflow into an adequately-sized common structure that shall serve as the wet well for RAS pumps.

An MBR building shall be provided. This building shall house all MBR-related equipment such as Scour Air Blowers, Permeate/Back pulse Pumps, and RAS Pumps.

In addition, the MBR Equipment building shall house all equipment necessary for all types/modes of membrane cleaning.
The Process Air Blowers for MBRs may be housed in the MBR building or a separate building.
In addition to fine screen, the drum screen upstream of MBR tank shall be provided.
Drum Screens clear openings for MBR: 1 to 2 mm

MBBR Basins

The bioreactor shall be designed to treat the peak flow sewage for organic load reduction along with BNR using an integrated fixed Film Activated Sludge system using free floating/moving cylindrical biomass carriers having more than 7years of life. The media/carriers shall be kept in suspension at any time by diffused aeration. MBBR tanks shall be aerobic stage for BOD removal.
The recirculation of activated sludge (RAS) may be provided depending upon bidder's design/proposal. The MBBR bio reactor shall be suitably sized to achieve the desired treated sewage quality. The shape of the reactor can be circular or Square or rectangular as per the bidders design, the shape should be so fixed so that it is suited for a compact and operationally flexible layout

Reactor Media shall be as per bidder's patented design but compatible with other media types for future operations considering about 20% variation in specific surface area. The media shall have a specific gravity of equal to or less than that of the waste water and be suitable of providing axial rotation in all planes as well as ensuring aeration to all surfaces. Aeration should be done through fine or coarse bubble diffusers.

Media Trap made from SS 304 (wedge wire screens) or superior material as approved by Employer shall be provided to ensure that media does not escape to the downstream unit. The size of the screens will be governed by the size of the bio-carriers. The entry and exit of waste water shall be at opposite ends both in horizontal &vertical plane. The reactor dimensions, media quantity shall be adequate for providing adequate sufficient surface area for maintaining the biomass required for degradation and air required as required to achieve the quality. The aeration system shall be provided for sufficient oxygen supply for the effective biodegradation in aerobic reactors. The level of dissolved oxygen in the Aerobic reactors shall be maintained minimum at 2.0 mg/l or above to facilitate the required biodegradation.

Blowers, piping, valves and other equipment to maintain air flow to the aerobic reactors must suit the needs of the media circulation and aeration of MBBR system. All systems and process equipment as necessary to meet the performance requirements will be provided by the Contractor.

Return Activated Sludge (RAS) Pump Station

For all STPs other than SBRs, RAS pumps shall be provided to return settled sludge from the Secondary Clarifiers or membrane-separated sludge from the MBR basins back to the Aeration Basins. A valve-controlled and metered tapping shall be provided from the RAS pump discharge header to withdraw Waste Activated Sludge (WAS) to solids processing unit. No separate WAS pumps shall be provided.

TERTIARY TREATMENT UNITS

To get the desired reusable quality treated sewage tertiary treatment is required.

Coagulation & Flocculation

STPs where phosphorus is treated by physico-chemical process, Flash Mixer along with complete coagulant dosing system, followed by Flocculation and Clarifier as separate units or combined clari-flocculator shall be provided as per specifications.

Rapid Sand Filtration

Sand filters shall be provided for further reduction in SS and/ or residual organics. Filtration system should be designed such that filtration rate shall be within the acceptable range as per CPHEEO while operating at average as well as peak flow rate. Filtration system shall include feed tank, feed pumps, filter beds with under-drain system as per design specifications along with pipe gallery, platform and necessary piping, valves/ Gates, gauges/ meters etc as per design and required for filter operation.

Pressure Sand Filters (PSF) shall be preferred for STP capacities less than 10MLD and Cloth Media Disk Filtration is also acceptable or any other proven technology.

Contractor to show calculation for filter operation during avg and peak flows without exceeding filtration rate. The inlet and outlet control arrangement to RSF shall be designed to permit 100% over load for emergency occasion.

Shape, size and quality of filter sand shall satisfy the following norms.

(a) Sand shall be of hard and resistant Quartz or quartzite and free of clay Fine particles soft grains and dirt of every description.
(b) Effective size shall be 0.45 to 0.70 mm.
(c) Ignition loss should not exceed 0.7 percent by weight.
(d) Uniformity coefficient shall not be more than 1.7 nor less than 1.3
(e) Soluble fraction in hydrochloric acid shall not 5% weight.
(f) Silica content should be not less than 90%
(g) Specific gravity shall be in the range between 2.55 to 2.65.
(h) Wearing loss shall not exceed 3%.
IS: 8419 (Part-1)1977 entitled filtration media sand and gravel may be referred for details.

For backwash purpose air scouring followed by backwash with wash water shall be provided. For back washing of filters, a back wash water tank should be constructed or provided on chemical house/ filter gallery which shall be filled with filtered water by backwash pumps. It must be able to back wash for minimum 10 minutes for minimum 2 units. The back wash head should be 9 to 10 m from bottom of tank to under drain of filter with necessary sluice valve.

Wash water pumps with valves, piping etc., shall be per design and requirement. Air scours system with Air blowers, valves, piping etc., as per design and requirement.

Dirty Backwash water from filters shall be collected in waste water collection tank and pumped back to STP head works.

UF System or Cloth Media Disc Filtration shall be provided to get the desired quality sewage for Reuse.

UV Tanks

UV System Tanks shall be provided for disinfection of treated sewage from the secondary and/ or tertiary treatment as per design. The UV units are envisaged for tertiary treatment of treated sewage.

UV units shall be floor mounted with closed pipe connections. UV unit shall be designed for effective design flow rate. UV units shall be oriented horizontally and shall be designed to operate continuously for 10,000 hrs as minimum without any need of maintenance or replacement.

Chlorination System

A complete Chlorination system with necessary safety accessory and controls shall be provided as per IS code.

SLUDGE HANDLING, TREATMENT AND DISPOSAL

Sludge sump and Pump Station

Thickened sludge sump shall be provided for the collection of sludge from biological treatment unit. The sump shall be equipped with Agitator assembly to facilitate mixing of sludge content. Thickened sludge pump station and pumps shall be provided for pumping of thickened sludge from the sump to the dewatering unit.

Dewatering Unit

A Dewatering unit shall be provided along with mechanical dewatering units (centrifuge/filter press/ bag filter/ screw press/ combi-machine) and all associated/ancillary equipment, including feed pumps, a complete polymer dosing system, dewatered sludge conveyors, sludge storage/loading hoppers and truck access and loading facilities. Sizing of the dewatering unit all related equipment shall be based on the operating schedule. Dewatering Unit shall be capable of handling sludge consisting of minimum 0.8 to 1% solids by weight. The dewatered cake shall be based on minimum consistency of 20% to 25% by weight dry solids.

NSTRUMENTATION AND AUTOMATION

SCADA based Instrumentation and Automation System shall be installed for proposed plant for various treatment units

DESIGN CRITERIA

Biological Process Requirements:

Biological Processes – Design Requirements					
Treatment	**SRT (d)**				

Processes		F/M (Kg BOD / Kg MLVSS. D)	MLSS (mg/L)	Aeration Tank HRT (hr)	RAS (% of influent)
MBBR	Designed based on 0.8 – 1.2 Kg BOD / m^3.d				
	Min. HRT of 4 hrs				
	Volume of MBBR Media – Min. 33% and Max. 50%				
SBR Continuous Flow and Intermittent Decant	15-20	0.05-0.08	3000-4000	Min 14 (without Anoxic / Selector Zone)	As per Bidders Design
SBR Intermittent Flow and Intermittent Decant	4-20	0.05-0.3	3500-5000	Min 14 (without Anoxic / Selector Zone)	
MBR	5 to 20	0.1 to 0.4	5000-20000	Min 6	0.5 to 2.00

Items	Unit	Values
Inlet Chamber		
Design flow	-	Peak flow
HRT	sec	60
Min. no. of unit	No.	1
Fine Screen Channels (Working)		
Design flow	-	Peak flow
Screen type	-	Bar screen/ Mat screen/ Step screen/ escalator type with mechanical cleaning
MOC – Channel	-	RCC
MOC – Screens (all screen components)	-	SS 316
Angle of inclination of screen	deg.	As per CPHEEO Manual
Max SWD at peak flow	M	
Approach velocity in channel	m/sec	
Velocity through openings at peak flow	m/sec	
Velocity through openings at average flow	m/sec	
Clear spacing between bars	mm	6
Fine Screen Channels (Standby)		
Design flow	-	Peak flow

Screen type	-	Bar screen with Manual cleaning
MOC – Channel	-	RCC
MOC – Screens (all screen components)	-	SS 316
Angle of inclination of screen	deg.	As per CPHEEO Manual
Max SWD at peak flow	M	
Approach velocity in channel	m/sec	
Velocity through openings at peak flow	m/sec	
Velocity through openings at average flow	m/sec	
Clear spacing between bars	mm	6
Grit Basins		
Design flow	-	Peak flow
Type	-	Mechanical Detritor or Vortex or Aerated Type with center drive, full diameter scraper
MOC – Equipment/Mechanism	-	SS 304
Design particle dia (sp gr – 2.65)	mm	0.1
Max Design SOR at peak flow	$m^3/m^2/day$	As per CPHEEO Manual
Min HRT at peak flow	sec	60
Organic return pump and organic wash pump	-	To be provided as per requirement (for each Detritor type grit chamber separately)
Grit Washer and Classifier		
Type	-	Reciprocating rake mechanism or screw conveyor
Aerated Grit Chamber		
Transverse velocity at surface	m/s	0.6-0.8
Depth-to-width ratio	-	1.5:1 to 2:1
Air supply	-	4.6-7.7 l/m/s of length 0.3-0.4 m^3/m^3
Detention time at peak flow	Min.	3-5
Quantity of grit	ml $/m^3$	7.5-75
Max Design SOR at peak flow	$m^3/m^2/day$	1,555
Vortex- Type Grit Chamber		
Minimum Velocity	m/s	0.15
Detention Time @ peak flow	sec	20-30
Parshall Flume		
Min No of Units	No.	1
MOC	-	RCC
Design flow	-	Peak flow
Minimum freeboard	m	0.5
Size	-	As per CPHEEO
Primary Clarifiers		

Drive type	-	Center-column supported with center drive. Peripheral drive or bridge-supported not allowed.
MOC – Structure	-	RCC
Conical bottom minimum slope	-	1 to 12
MOC – Center column	-	MS Epoxy coated
MOC – Bridge	-	MS Enamel painted
MOC – Mechanism	-	MS Epoxy coated
Max SOR at average flow	$m^3/m^2/day$	As per CPHEEO Manual
Max SOR at peak flow	$m^3/m^2/day$	
Max SLR at average flow	$Kg/m^2/day$	
Max SLR at peak flow	$Kg/m^2/day$	
Max Weir loading at average flow	cum/day/m	
Minimum SWD	m	
Scum removal	-	To be provided by bidder
Primary Removals and Primary Sewage Characteristics		
BOD Removal	%	As per CPHEEO Manual
TSS Removal	%	As per CPHEEO Manual
Anaerobic Basin		
MOC – Structure	-	RCC
Min SWD	m	5
Min Freeboard	m	0.5
Min HRT at Average flow	Hrs	As per CPHEEO Manual
Anoxic Basin		
MOC – Structure	-	RCC Tank equipped with mixers
Min SWD	m	5
Min Freeboard	m	0.5
Min HRT at Average flow	Hrs	As per CPHEEO Manual
Aeration Basin (Refer Table above for Biological Process requirements)		
MOC – Structure	-	RCC
Min SWD	m	5
Min Freeboard	m	0.5
Specific sludge yield	kg sludge production/ kg BOD	As per CPHEEO Manual
Min HRT at Average flow	Hrs	
Recycle Configuration		
Hydraulic design of wet well	-	Minimum HRT 30 Min for upto flow of 75% of return sludge capacity
RAS Ratio ® – hydraulic design	-	As per CPHEEO Manual
Aeration System		
BOD oxidation oxygen requirement	kg/d	1 to 1.2 x Inlet BOD load avg.

Type of Aeration	-	* Type of Aeration- Diffused Aeration or Aspirator Aeration.
*Note- - The proposed aeration system shall be in successful operation in STP since last three (3) years in India.		
Diffused Aeration System		
Max Alpha Factor, α	-	0.6
Max Beta Factor, β	-	0.95
Max Fouling factor, F	-	0.8
Oxygen demand peaking factor	-	1.0
Aeration system sizing basis liquid temperature	-	Max liquid temp
Aeration system sizing basis air temperature	-	Max air temp
Aerobic basin DO (min)	mg/L	2
Diffuser type	-	Fine bubble diffuser (Disc or Tube type) Coarse bubble diffusers are acceptable for MBBR process only
Diffuse Installation	-	Retrievable
Diffuser material	-	EPDM or silicone elastomer with anti-microbial coating
Min no of diffusers – Uninstalled shelf spares	%	10
Max. SOTE per unit diffuser submergence at peak air flow (for design calculations)	%/m	5
Process Air Blowers		
Blower type	-	Rotary lobe with Variable frequency drive (VFD) with acoustic enclosure
Capacity	%	110 (All systems shall use Dissolved Oxygen/Oxygen Uptake Rate control with VFD driven Blower)
No of blowers – Working	Min.	1
No of blowers – Standby	Min.	1
Process Air Blower Building		
Structure	No.	1
MOC – Roof, columns, beams	-	RCC
Aspirator Aerator		
Capacity	%	110
Aerobic basin DO (min)	mg/L	2
Max Alpha Factor, α	-	0.85
Max Beta Factor, β	-	0.95
Oxygen Transfer Efficiency	Kg O_2/kWh	1.2 to 2.4
Mixing Power Requirement	W/m^3	15-26

MBBR Basin		
BOD Loading	Kg BOD / m^3.d	As per CPHEEO Manual
Aerobic HRT (Min.)	hrs	
Water Depth (Minimum)	m	
MBBR Media		
% of MBBR Media required	%/volume of MBBR Tank	As per CPHEEO Manual
MBBR Surface Area	m^2/m^3	
Shape	-	
MOC	-	PE/ PU PP/UPVC (Only virgin plastic)
Corrugation	-	One side (Inside)
Min. expected life	years	7
MBBR media supplier	-	World Water Works, Headworks International, Anox Kaldness, Thermax Ltd., Aqwise, Cooldeck or equivalent quality media with submission of credential and end user certificate
Secondary Clarifiers		
Type	-	Circular, center-column supported with center drive, and center or peripheral feed. Peripheral drive or bridge-supported not allowed.
Sludge and scum removal	-	Center sludge hopper sized per most rigorous published criteria. Full-radius scum baffle with beach-type skimmer.
MOC – Structure	-	RCC
Conical bottom minimum slope	-	1 to 12
MOC – Center Column	-	MS Epoxy coated
MOC – Bridge	-	MS Enamel painted
MOC – Scraper and Skimmer	-	MS Epoxy coated
Max SOR at average flow	m^3/m^2/day	As per CPHEEO Manual
Max SOR at peak flow	m^3/m^2/day	
Max SLR at average flow	Kg/m^2/day	
Max SLR at peak flow	Kg/m^2/day	
Max Weir loading at average flow	cum/day/m	
Clarifier SWD	m	As per CPHEEO
SBR Basins		
SBR Basin	No.	2 (minimum)
MOC – Structure	-	RCC
Max. SWD	m	As per CPHEEO
Min Freeboard	m	0.50

Cycle time	hrs	As per CPHEEO Manual
Min. Aeration time, Settling time and Decant time	hrs	As per CPHEEO Manual
Min. HRT	hrs	14
Decanting mechanism	-	Swing down / float type
Decanting depth shall be designed to meet the specified performance standards for treated sewage. Any shortfall in meeting the performance standards due to decanting depth observed during commissioning and operation of the plant shall be corrected by successful bidder at his own risk and cost.		
No. of RAS pumps	per basin	1 W+1 S
Selector Zone HRT.	Min	As per CPHEEO Manual
Specific Sludge Yield (for all technologies)	Kg sludge production / kg BOD	
MBR Basins		
Membrane Type	-	Flat sheet, Hollow yarn membrane
Membrane Material	-	PVDF /PS/PES
Membrane in Tank	-	Immersed in Bioreactor (side stream is not allowed)
Flux	LMH	As per CPHEEO Manual
Diffusers in Bioreactor	-	Fine Bubble diffused aeration
Diffusers in MBR Tank	-	Fine Bubble diffused aeration
Applied Vacuum	Kpa	5 to 30
Chemicals for Membrane cleaning	-	NaOCl and Citric Acid
Type of cleaning	-	CIP (cleaning in place)
Flash Mixer		
Detention time	sec	As per CPHEEO Manual
Velocity Gradient	s^{-1}	
Mixing Mechanism	-	Mechanical as per IS 7090- 1985
Flocculator		
Detention time	min.	As per CPHEEO Manual
Velocity gradient	s^{-1}	
Mixing Mechanism	-	Mechanical as per IS 7090- 1985 (Type C)
Total Area of Paddles	-	As per CPHEEO Manual
Max. Peripheral velocity of blades	m/sec	
Surface loading rate	liters/hour/sq.m	
SWD	m	
Filtration System		

Type	-	Pressure Sand Filters for STP capacities less than 10MLD Rapid Sand Gravity Filters with shed for capacity above 10MLD only. Cloth media disk filtration is acceptable or any other proven technology
Rapid Filtration		
Filtration rate	$M^3/m^2/h$	As per CPHEEO
Area per bed	M^2/ individual bed	
No. of beds	-	Minimum 2 Nos of beds shall be provided.
Min. depth of water over sand top	m	2 m (Without free board).
Min. Free board	m	0.5
Depth of Sand media	m	As per CPHEEO
Depth of Gravel media	m	As per CPHEEO
Area of orifices	-	0.3% filter bed area The perforations vary from 5 to 12 mm. In diameter and should be staggered at a slight angle to the vertical axis of pipe.
Area of laterals	-	2 x Area of Orifices
Area of Manifold	-	1.5 x Area of laterals
The inlet and outlet arrangement to RSF	-	designed at 100% over load to permit for emergency occasion
Wash Water Tank	-	Separate O/H wash water cum service water tank suitable for backwashing minimum 2 Nos. of filter beds at a time with 8 to 10 Mtr. Head
Wash Water Pumps	-	100% standby Rate 36m3/m2/h or 600LPM per Sq.m. for 10min
Air Blowers	-	Rate 45-50 m3/h per sq.m of free air flow at 0.35 to 0.4 Kg/sq.m for 5min at the under drains (100% standby)
Wash Water Recycle Pumps	-	2 x 100 % capacity pumps suitable to empty the wash water collection tank in 4 hours
Chlorine Contact Tanks		
MOC	-	RCC
Min HRT at Average flow	min	30
Min effective L/W ratio	-	40

SWD/Pass Width ratio	-	1
Min freeboard	m	0.5
Feed Sump & Pump (Dewatering Influent, DWI)		
Min no of Sumps	No.	1
MOC – Roof, columns, beams	-	RCC
Min. HRT	hrs	10
Type of Mixing	-	Coarse bubble/Mechanical mixers
Operation schedule	hrs/day	12
	days/week	6
Min no of pumps – Working	No.	1
Min no of Pumps – Standby	No.	1
Type of Pump	-	Progressing Cavity
Mechanical Dewatering Unit		
Min no of units – Working	No.	1
Min no of units – Standby	No.	1
Type of Sludge dewatering Equipment	-	As per bidder proposal Centrifuge/belt Filter press Auto operated with minimum sludge man contact Bag Filter is acceptable only for plant capacity below 3MLD
Min dewatered sludge (DWSL) TSS required	% w/w	20%
Min solids capture required	%	90%
Polymer System		
Type	-	Dry polymer / Liquid polymer
Minimum polymer dose	kg/ton dry solids	2
Note: Provision for dosing Dewatering Polyelectrolyte (DWPE) shall be made in thickener as well as dewatering facility.		
Dry Polymer Storage		
Type	-	Covered bin
MOC	-	GRP
Minimum storage period	days	30
Polymer Batch Tanks		
MOC	-	GRP/ HDPE
Poly solution strength	% w/w	0.10%
Min no of tanks – Working	tank	1
Min no of tanks – Standby	tank	1
Polymer Tank Mixers		
Min no of mixers per tank	No.	1
MOC - Impeller and shaft	-	SS316
Type	-	Turbine
Polymer Metering Pumps		
Type of Pump	-	Hydraulic double diaphragm

Min no of pumps – Working	No.	1
Min no of pumps – Standby	No.	1
Dewatering Facility Building		
Min no of units	No.	1
No of levels	No.	2
MOC - Roof, columns, beams	-	RCC

Note: Contractor can provide alternative MOC for different units with approval of employer that have equal or more service life.

Indicative Vendor list

S.No.	Equipment/ Item	Approved Vendors
1.	Centrifugal Pumps	KSB Pumps, Grundfos, Jyoti Limited Mather & Platt, Kirloskar Brother Ltd
2.	Submersible Pump	Kirloskar Brother Ltd, Grundfos, ABS KSB
3.	Dosing Pumps	Asia LMI, Sandur fluids control, V.K.Pump industries.
4.	FRP Storage Tanks	Sintex
5.	Blower	Everest/Kay
6.	CS Pipes	Zenith, Tata Iron & Steel Company Ltd., Surya Roshni Limited, Jindal Indus Tubes Limited, Madras Steel & Tubes, Chennai
7.	SS Pipes	Decora Tubes Ltd, Industrial metal corp, Maharashtra Seamless Ltd Ishardas Aggarwal & Sons
8.	CS & SS Fittings	Arvind Pipes & Pipe Fittings, Alliance Fittings & Forgings Incorporated, Mumbai, Gujarat Infra Pipes Pvt. Limited, Baroda, MS Fittings Manufacturing Co. Pvt. Limited, Kolkata, Super Forge, Mumbai Gautam fittings, Mumbai
9.	Bolts & Nuts	Radicon Engg. Co., FE Darukhanawalla and Co., Maharashtra bolts & nuts, Industrial fasterners. GKW Unbrako, TVS
10.	Gaskets	Gaskets India Pvt. Ltd, IGP Engg. Ltd, Mechanical Packing Industries.
11.	Paints	Berger, Nerolac, Asian paints, shalimar paint
12.	Diaphragm valve	Floway Valves, BDK, Audco, Intervalve

S.No.	Equipment/ Item	Approved Vendors
13.	Globe valve	A.V.Valves, BDK Engg Industries, Ltd.Chemtech Industrial Valves Pvt.Ltd., DemblaValves Globe Industrial Valves
14.	Check valves (wafer)	Intervalve, BDK, Advance, Audco
1.	Programmable Logic Controllers (PLCs)	ABB, Siemens, Rockwell Automation, Schneider, GE Fanuc
2.	Panel Enclosures	Rittal / Enclotek
3.	On-Off Valves with Actuators	
(a)	Ball Valves	Festo, Virgo, Dezurik, NAF, Neles (Metso Automation)
(b)	Butterfly valves / Diaphragm Valves	Fisher Xomox India Ltd., Neles (Metso Automation) NAF, IL, Masoneilan Dresser Valves, Samson Valves
(c)	Knife Edge Gate Valves	DEZURIK, VAAS Industries
4.	Solenoid Valves	ASCO, Norgren, Rotex, Schradder, Festo
5.	Air Filter Regulators	Norgren, Placka, Fair Child (Precision), Festo (Precision)
6.	Pressure Gauges / Pressure Switches	General Instruments Consortium, FIEBIG, Waree, Pyroelectric, Wika
7.	Differential Pressure gauge with Switch	General Instruments, Wika, Pyroelectric
8.	Conductivity type Level switches	Pune Techtrol, Nivo Controls, Levcon
9.	Reflex Type Level Gauges	Pune Techtrol, Waree, Nivo Controls
10.	Magnetic Flowmeters	Emerson, ABB, Yokogawa,Endress & Hauser
11.	Rotameters	TRAC, Fitzer, Forbes Marshall, Fiebig
12.	Orifice Plates	General Instruments Consortium, Starmech, Pyroelectric
13.	pH Meter	Endress + Hauser, Yokogawa, Emerson, Mettler-Toledo India Private Limited

S.No.	Equipment/ Item	Approved Vendors
14.	Conductivity meter	Endress + Hauser, Yokogawa, Emerson, Mettler-Toledo India Private Limited
15.	ORP Analyser(Residual Chlorine Analyser)	Endress + Hauser, Krhone Marshall, Emerson
16.	24 V DC Power Supply Units	Aplab, Pheonix, Cosel
17.	Junction Boxes (Thermoplastic)	Hensel
18.	Cables	TCL cables Delton cables, LAPP Cables, Finolex, Udey Pyrocables
19.	Cable Glands	Braco, Comet, Baliga, R. Stahl
20.	GI Cable Trays	Indiana, Profab, Patny, Sterlite, Reliance
21.	Relays	Siemens, OEN, Omron
22.	Limit Switches	Siemens, BCH, Jai Balaji, L&T
23.	Terminals	Elmex, Connectwell, Wago, Phoenix
24.	Instrument erection Hardware	Parker, Swagelok, Excel Hydropneumatics, Wintec Champ Instruments & Engineers

1.1.14. Commissioning of the System

On completion of the Trial Run, commissioning of the System shall be done by the Contractor. The total time allotted for commissioning of the full system is 30 days. The commissioning of the system shall be considered as fully achieved after the entire system has run continuously for a period of 7 days without any breakdown to the satisfaction of Engineer. If continuous run is not achieved fully to the satisfaction of Engineer, the Contractor has to do the needful to achieve the same at his cost.

All the Costs including the cost of staff, water , electricity, chemicals, other consumables that are required for Operation & Maintenance of System during Commissioning period shall be borne by Contractor. It is the obligation of contractor to dispose off the water from the pipe line, if required as per the direction of employerto the nearest water body/ drain in an environmental friendly manner without affecting the project area.

1.1.15. Documents to be submitted by Contractor

Contractor shall submit following documents/drawings for approval from employer before execution of work.

- Topographical survey and drawing

- Series of low jet fountains (nos as/site plan) to be done between CCC block and auditorium block.
- Open air theater to be done as shown in the site plan.
- Heavy duty green pavers to be provided at all surface parking adequate for vehicular load and confirming griha cerification.
- Mounds to be created as shown in the site plan.
- A musical fountain along with ss or stone sculpture of minimum height 4.5 m at the centre, stone seating around to be provided in front of the auditorium building in the south east corner as shown in the site plan. The minimum dia of the musical fountain to be 10.5m with minimum 20 primary nozzles with spraying height of 20m with adequate interactive light arrangements and necessary filter arrangements as approved by the Eng in charge.
- The landscape lighting to be followed by the landscape site plan and as/specification. How ever the no of trees and landscape lights may be increased as per the consultant if required.

1.2.9.1 Design Intent

Concept of Landscape Design:

The proposed campus includes an Auditorium & Convention Centre, Tribal Museum, and a Command Control Centre facilitating data management of the whole ABD area along with related amenities of Open recreational spaces.

Landscape for rOURkela one is designed in a manner that will appeal to a wide array of users in holistic way; visiting from the neighbouring sectors as well as from outside of ROURKELA.

Design of landscape spaces is a result of Combination of form of master plan of entire complex and movement pattern of users to create various activity zones interconnected to each other.

Landscape features selected for rOURkela one are based on recreational activities relevant to the master plan and Smart city components that can be utilized in planning of open space.

Following list is a broad outline of features proposed

- Land modulation in the form of lawn mounds along pedestrian walkways to create varied size of open space pockets
- Palm tree avenues along internal roads to reduce the load over podium/basement slab
- Sculpture corners as per overall concept with paved seat-outs
- Decorative light fixtures with appropriate design as per requirement

Along with above mentioned features following smart amenities are proposed to support smooth functioning lake redevelopment,

- Parking area equipped with Electrical vehicle charging points
- LED landscape light fixtures
- Easy to maintain materials for paving
- Garbage disposal system with slotted dustbins

Trees- The trees to be planted as/drawing and all trees should have a minimum height of 2.4m.and the shrubs to be as/drawing except for Roystonea Regia(minimum height to be 3.6m)

Heavy duty grass pavers-

Providing and laying 450x450x80 mm thick grasspaver (with minimum 50% grass) on 150mm thick sub grade of compacted bed of 20mm thick nominal size stone aggregate and base course and filling with 150mm thick sand including spreading, well ramming, consolidating and finishing smooth etc. All complete as per direction of engineer-in-charge.

Interlocking paver blocks with pebble joints-

Providing and laying 60 mm thick of m-35 grade factory made chamfered edge cement concrete paver blockmade by table vibratory method using pu mould, laid in required colour & pattern over 50mm thick compacted bed of course sand, compacting and proper embedding/laying of inter locking paver blocks into the sand bedding layer through vibratory compaction as per manufacturer's specifications & direction of engineer in-charge.

Stone paving

40 mm thick fine dressed leather finished mint sand stone flooring of size 600mm x 600 mm over 20 mm (average) thick base of cement mortar 1:5 (1cement : 5 coarse sand) with joints finished flush on adequate sub base.

Kota stone flooring

25 mm thick kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement Slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand).

Tree grating

Each tree surround consists of 4 nos panels of 750mm length x 750mm width x 40mm thickness overall dimensions: 1500mm (length) x 1500mm (width) x 40/100 mm (thickness) suitably reinforced for long use and to prevent damage during transportation & handling

Manufactured with m-30 grade of concrete using vibro-compaction process using jointless frp moulds so as to achieve shuttering finish on five faces and gurmala finish on the top surface. A choice of standard colors and unlimited custom colors will match any natural stone finish or interlock pavers in the surrounding(except for the trees whic are there on planter bed.

Stone coping

Providing and fixing 40 mm thick judhpur/golden sand stone coping laid over 20mm thick base cement mortar 1:4 (1 cement : 4 coarse sand) joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. Complete at all levels.

Glass mosic tiles

Providing and fixing glass mossaic tiles at finished plain wall surface of size 20 mm x 20 mm x 4 mm in all colour, design , fixing in customize design as per direction of engineer-in- charge. The glass mosaic tiles to be fixed on the wall surface with the help of approved adhesive applied at the rate of 2.5 kg per sqm and grouting of the same. The rate is inclusive of all operation, material and required pattern approved by engineer-in-charge:

1.2.10 OTHER MISC WORKS

Scope of work includes design and construction of following works:

- Dismantling of existing structures
- Site development and land grading including removal of slushy soil, debris and filling of borrowed earth to the required formation level
- Construction of compound wall.
- Design and construction of watchman's cabin/ guard room as shown in drawing
- 60mm thick inter locking paving block for surface parking area.

1.3 SURVEY AND INVESTIGATIONS:

All the necessary surveys and investigations such as Geotechnical investigations, topographical survey, etc. need to be carried out by the contractor as per the project requirement under the concurrence of Engineer in charge.

1.4 SAFETY

- Contractor has to take care of all safety measures as per Owner / Engineer-in-charge's HSE requirements.
- Proper management of loose earth, mud, water, oily material is to be ensured to avoid making the area messy and slippery.
- Working area needs to be properly cordoned off and proper care is to be taken so that surrounding equipment, instruments etc. are not damaged during the construction.
- An experienced safety engineer shall be deployed to site to ensure that the construction work is carried out in a safest manner and shall work in coordination with Owner / Engineer-in-charge's safety Engineer.

Following codes shall be followed as applicable as per direction of engineer.

CONSTRUCTION SAFETY	IS 3696 (Part 1):1987 Reaffirmed 2017	Safety code of scaffolds and ladders: Part 1 Scaffolds(first revision)
CONSTRUCTION SAFETY	IS 3696 (Part 2):1991 Reaffirmed 2017	Safety code of scaffolds and ladders: Part 2 Ladders(first revision)
CONSTRUCTION SAFETY	IS 7969:1975 Reaffirmed 2017	Safety code for handling and storage of building materials.
CONSTRUCTION SAFETY	IS 8989:1978 Reaffirmed 2015	Safety code for erection of concrete framed structures.

1.5 CO OPERATIONS WITH OTHER CONTRACTORS:

The contractor shall provide all facilities and give complete co-operation for the execution of various other works, if required to be carried out simultaneously by other agencies, while his own work is in progress. Other contractors are also likely to work in the same area during the construction stage.

1.6 TIME PERIOD FOR COMPLETION

The total period of contract including Survey, Investigation, Soil Exploration and Laboratory Testing, detailed Design, and Execution shall be **24 calendar months**. The defect liability period for the building shall be **Three (3) years** from the date of completion of the project.

The Contractor shall carry out the design proofing from the Engineer in Charge or any Engineering Institute of National Repute at his own cost.

The Contractor shall submit all designs, drawings, technical specifications and methodology to the Client. The Client shall give approval on all sketches, drawings, reports and recommendations and other matters and proposals submitted for approval by the Bidder in such reasonable time as not to delay or disrupt the performance of the Contractor's services.

1.7 SCHEDULE FOR COMPLETION OF TASKS

The reports have to be submitted in the following phasing in the number of copies indicated against each of them.

SL No	Description	Schedule of Completion
1	Details of survey including laboratory test report	15 days from the date of signing of Agreement

2	Architectural and draft structural drawings with detail engineering designs and technical specifications & methodology	30 days from the date of signing of Agreement
3	Statutory Approval from relevant authorities	60 days from the date of signing of Agreement
4	Final structural drawings with detail engineering designs and technical specifications & methodology	90 days from the date of signing of Agreement
5	Changes in Scope during construction	As and when directed by the Client/Engineer

The Bidder shall be required to form a multi-disciplinary team for this assignment with qualified & experienced key personal and other required supporting staff for delivering the final output . The design as well as Architectural team should have the requisite experience and expertise for design of similar works as offered by the bidder and accepted by the Client.

The CVs of the Key Personnel's would have to be got approved by the Client during contract negotiation and prior to signing of contract

Final Outputs (Reports, Drawings etc) required from the Bidder

- Report with details of all Survey including laboratory test (3 Hard copies along with one Soft copy)
- Draft detailed Architectural drawing and engineering designs report (3 Hard copies along with one Soft copy)
- Final detailed Architectural drawing and engineering designs report (3 Hard copies along with one Soft copy)
- As Built Drawing after Completion of Construction(3 Hard copies along with one Soft copy)

B. TECHNICAL SPECIFICATION

The works shall be performed conforming to the Indian Standard codes, specifications as per P.W.D, PHED, OERC, NBC, etc as applicable. Wherever such specifications are not available, CPWD specifications, relevant references, manuals etc. shall be followed as directed by Employer.

ARCHITECTURE

1. ITEM OF WORK

1. Concrete shall be with conformity to I.S.456.
2. Foundation shall be with conformity to I.S.1080.
3. C.R. Masonry shall be with conformity to I.S.1597.
5. Brick masonry shall be with conformity to I.S.2212.
6. Cement plastering shall be with conformity to I.S.9103 & 6925.
7. Mortar shall be with conformity to I.S.2250
8. White and colour washing shall be with conformity to I.S.6278.
9. CC in foundation shall be with conformity to I.S.2571.
10. Anti-Termite Treatment shall be with conformity to I.S.6313. (Part I & Part II)
11. Painting to all surfaces shall be with conformity to I.S.2395 (Part I & Part II)
12. DPC shall be with conformity to I.S.3067
13. Tar felt treatment shall be with conformity to I.S.1346
14. Steel painting shall be with conformity to I.S.1477 (Part I & Part II) I.S.1661

2. BRIEF SPECIFICATION OF ITEMS USED

It is the intent of these specifications to establish acceptable standards of quality and to provide the Contractor with complete and detailed information and subsequent instructions necessary to enable him to submit a well planned Tender, to carry out the design, where and when required, and to execute properly the work prescribed. This specification covers the general requirements for civil and architectural works comprising of masonry, flooring, skirting, dado, plastering for wall and ceilings, painting, doors, windows, ventilators, Builders hardware, ironmongery, Glass and glazing, Partition works, False ceiling works, toilet cubicles, sanitary fixtures and fittings, waterproofing, Metal sheet cladding, grills and railing works.

Standards and Codes

i. The Contractor shall follow the Indian Codes and specifications for his work.

ii. All standards and codes employed or referred to shall be the latest current issue in effect at the date 28 days prior to the Tender submission date.

iii. In case of discrepancies between these Specifications and national or international standards and codes, these Specifications being only indicative in nature shall not govern, unless otherwise established by the Authority in each particular case.

Termite Treatment:

Providing and injecting chemical emulsion for pre - constructional ant termite treatment as per IS specification and creating a chemical barrier in bottom and sides of foundation trenches, top surface of plinth filling junction of walls and floors along with external perimeter of the building expansion joints surrounding the pipes and cables etc. complete using approved quality of chemical emulsion of requisite quantity prescribed by the manufacturer as directed by the Engineer-in-charge including cost of all materials and labour taxes etc. complete. (Indemnity bond for warranty for 10 years to be furnished)

Waterproofing:

Over Head Tank:

- **Construction/Starter joint Treatment:** Providing and applying water swellable-basic polymer-hydrophilic water stoppers at all construction joints, water stoppers shall have unrestrained volumetric expansion up to 300%, Shore A hardness of 40 to 50, Hydrostatic pressure resistance of 100 meters. Water stoppers may be fixed to the concrete using any approved Adhesive and Complete as per the manufacturer's specification.
- **Bore Packing:** Preparing the inside surface of core and PVC by roughening using suitable file to get better adhesion prior to packing works. Cleaning the surface by wire brushing followed water jet to remove any laitance or loose flaky particles. Providing necessary formwork for packing the bore using suitable arrangement (depending upon site conditions). Applying a coat of styrene- butadiene based polymer coating using any approved brand to enhance adhesion between the packing material and other surfaces and Application of Bath seal Tape at the middle of over the pipe external side and Packing the gap using non-shrink cement polymer based using Micro concrete up to the surface of the bore whilst the polymer is in tacky state.
- **Treating the Cracks, Construction Joints** : Chase opening the Construction Joints by providing " U " groove, removing the dust and clean the designated area fill the prepared surface using Micro concrete completely as per the manufacturer's Instruction, following by providing chemical injection treatment in the form of pressure grouting to the cold joint by injecting cement slurry mixed with grout admixture @ 225 gms per bag of cement, in the required consistency through the pre fixed PVC nozzles in the 18 mm dia holes, fixing of PVC nozzles with instant plug and final cutting the projected nozzles and sealing off the PVC nozzles after the injection operation is over with Cement Mortar 1:3 admix with the bonding agent, non-shrink rapid setting mortar compound, finishing, curing etc. as per manufacturers specification and as directed.

- **Coving:** Coving at the junction of slab and vertical offsets with CM 1:3 mixed with approved bonding agent at the dosage of 5Litre/bag of cement under.
- **Surface Preparation**: Surface to be free from frost, surface laitance and contamination free from loose aggregate or other sharp protrusions with fairly smooth finish for application of waterproof coating prime the surface with water.
- Applying 2 coats of approved bonding adhesive (a two component, pre packed, polymer modified cementitious coating) @ 1.9kg/sq.mtr all over the slab including the angular fillets and extendable over the vertical walls having Mixed density 1950 kg/m3 Resistance to positive water pressure (DIN 1048)Pt 5 - 5 bar , Resistance to negative water pressure (ITM / FTM-181) 3 bar , Static crack accommodation 0.9 mm,, Abrasion resistance (ASTM D4060)- Wear Index (equivalent to 40 N concrete.) CO diffusion resistance> 50 m, Pot life at 20°C- 2hrs,WARS certified food grade coating.
- **Water proofing membrane:** Providing and applying one coat of solvent free epoxy/PU primer @ 0.2 Kg/ sqmt , followed by 2 coats of liquid thixotropic, applied waterproof and protective, non toxic lining system using a two component, 100% solids, aromatic Polythane elastic coating possessing non-toxic, potable water contact capability properties of total 1.5 mm thick at consumption of 1.8kg/sqm. The membrane possess tensile strength of 8Mpa, Shore A Hardness >90, Shore D Hardness >50; Elongation property >100%, Concrete Adherence of >1.5Mpa at 23 deg.C. with EuroClass F as fire reaction, solid content 100% as per ISO 527-3 properties.
  The entire system for supply of material and installation of system will be done by the inhouse/subsidiary company of the manufacturer with a comprehensive warranty for 10 years for both supply and installation of the waterproofing system. The turnkey specialist waterproofing sub contractor shall be an ISO 9001 certified and CIDC accredited company having a successful track record in executing waterproofing works for a minimum of 10 years .

Basement Water Proofing:

- Supplying and installing 4mm thick pre-applied blended polyethylene /polypropylene waterproofing membrane with a cell mesh provides mechanical bonding to poured concrete conforming to the requirements of BS EN 13967:2004 and BS 8102:2009 having properties Tensile strength (Peak) EN 12311-2 in Longitudinal 10N/mm2 , in Transverse 8.0 N/mm2 ,Elongation (Peak) ASTM D412 300% ,
- Tear resistance > 600N, Resistance to impact (EN 12691) Method A 1500 mm , Reaction to fire EN ISO 11925-2 pass, Joint strength EN 12317-2 >220 N (lap) & >150 N (butt).

- The system should be Mechanically bonded to the RCC. The size of the membrane should not be less than 30metre * 1.27metre & 4-5mm thick with lap joint 80mm to minimize the joints.
- Horizontal to vertical joints - Provide L strip at the horizontal & vertical interface, Corner strip at the corners
- The entire waterproofing treatment should be guaranteed by the principal manufacturer/in-house applicator as a system, for ten years, materials, labours, tools, tackles, etc., complete.

Retaining Wall:

- All tie rod holes are to be packed with swell able Sealing Plug.
- Supplying and applying highly elastomeric, self levelling two component 100% solids polyurethane polyurea hybrid liquid membrane, having elongation of 600% and tensile strength of 6Mpa, crack bridging ability of 3mm, bonding strength to concrete @1.5N/mm^2 and tear strength of 30N/mm, applied at 2.3kg/Sqm to achieve a minimum thickness of 2 mm. The system includes base preparation of cleaning, brushing and removal of flacky materials, grouting the porous area with cementitious grout, proper coving between slab and wall junctions and priming the surface with epoxy resin based primer applied @ 150gms/Sqm.
- The entire system of supply of material and installation should be done directly by the manufacturer through in-house team with a guarantee of 10 years against leakages, to be supported by an insurance backed system guarantee (for both supply and application) for a period of 5 years and for 20% of the contract value.
- Providing & Fixing of protection board 8MM – HDPE Dimple board spot bonded on retaining wall before backfilling, compressive strength not less than 200N/mm^2
- Terminating the membrane into a 20x20mm groove and filling the same with PU sealant.

Horizontal Areas (Below Raft):

- Supplying and installing 1.8mm thick self-adhesive HDPE membrane prebond having puncture resistance of 1000N (±5%) as per ASTM E 154; elongation of >500% as per ASTM D 412; tensile strength of HDPE film without adhesive is 25MPa; peel adhesion to concrete 880 N/m (±5%) as per ASTM D903 and hydrostatic head resistance not less than 60m head of water (ASTM D 5385); UV exposure upto 21 days pass. The system should be fully bonded to the RCC and consists of highly resilient HDPE film, self-adhesive polymer layer and a trafficable granular layer. The membrane shall have 100mm side and end laps which shall be sealed with double sided adhesive tape. All vertical surfaces will be fixed using prefixed gaskets/shot gun. The size of the membrane should be 3Mtr. x 20

Mtr. to minimize the joints and the entire waterproofing treatment should be guaranteed by the principal manufacturer/in-house applicator as a system, for ten years, materials, labours, tools, tackles, etc., complete.

- Providing and installing a hydrophilic swelling water stop at all construction joints of the raft slab and retaining walls using a Polybar (non-bentonite) Hydrophyllic swellable water bar of 20mm x 10 mm cross section size.
- TECHNICAL PROPERTIES ;
- Volume expansion in rain water : 500% (+ 10%)
- Volume expansion in concrete water : 400% (+ 10%)
- Colour : Blue
- Hardness : 35 Shore A
- Tensile Strength : > 2 MPa
- Elongation : > 400%
- Density : 1.22 g/cm3 (+ 10%)
- Temperature range : -20 + 75oC
- Weather resistance : Excellent

Basement roof non tower area with landscaping above and green terraces :

- **Waterproofing membrane, geotextile and protection screed :**
- Providing and applying a Fully Bonded Liquid applied Hybrid Polyurea Polyurethane Waterproofing Membrane of total 1.50 mm thick system DFT having anti-root properties, to be applied in Min 2 coats, over one coat of a solvent free two component epoxy primer. No sand broadcast layer is permitted in the system. The system must be such that it is thixotropic, can be applied by airless spray, as well as the same product shall be capable of being applied manually for detailing and patch repairs. The system must not be instant setting and shall have a min pot life of 15 mins to facilitate WFT measurement at every 10 to 15 Sqm during application to check thickness and thereby not require destructive testing for thickness measurement. The Product shall be applied in accordance with the manufacturer's guidelines.

  Systems that contain Bitumen and/or those that are hot applied , or involve heating, shall not be permitted to be used
- The waterproofing membrane shall have following minimum properties :

  1) Solid contents by volume : 100%

  2) Tensile strength > 10 Mpa as per ASTM D 412

  3) % Elongation > 900% as per ASTM D 412

  4) Bond strength on concrete >2.0 Mpa as per ASTM D 7234

5) Crack bridging capability of Over 3 mm.

6) Resist hydrostatic pressure of over 60m head of water as per ASTM D5385;

7) Specific Gravity of 1.15 (=/- 10%)

The Waterproofing system shall be suitably protected prior to backfilling with a Protection layer of Min 300 GSM non-woven Polypropylene Geotextile, to be loosely laid with min 75 mm overlaps, over the waterproofing membrane for the horizontal surfaces . Horizontal surfaces shall be covered with a protection and slope making screed of Min. M20 Grade Concrete of Avg 100 mm thick with min 50mm at the outlet and laid to a slope of 1:120 well compacted, including curing etc complete.

Verticals shall be protected with an epoxy bond coat, followed by quartz sand broadcast and followed by Protective plaster of Avg. 12mm thick in C.M(1:4).

- **Drain filter/board - extra for landscaping areas only:**
- Supply and installation of Rolled Matrix Soil Filter cum surface drainage System as per manufacturers' specifications consist of dimple raised, moulded polypropylene sheet bonded to a high strength polypropylene geotextile fabric. This geotextile fabric composite allows passage of moisture through fabric while preventing fine soil from entering to drainage channel and has a compressive strength of 600 Kg/Sq.Mt. and thickness of 11mm.

Terrace Water Proofing:

- **Surface Preparation:** Surface to be free from frost, surface laitance and contamination free from loose aggregate or other sharp protrusions with fairly smooth finish to receive the waterproofing membrane.
- **Bore Packing**: Preparing the inside surface of core and PVC by roughening using suitable file to get better adhesion prior to packing works. Cleaning the surface by wire brushing followed water jet to remove any laitance or loose flaky particles. Providing necessary formwork for packing the bore using suitable arrangement (depending upon site conditions). Applying a coat of styrene- butadiene based polymer coating using approved bonding material to enhance adhesion between the packing material and other surfaces and Application of approved adhesive at the middle of over the pipe external side and Packing the gap using non-shrink cement polymer based using Micro concrete up to the surface of the bore whilst the adhesive is in tacky state.
- **Coving**: Coving at the junction of slab and vertical offsets with CM 1:3 mixed with approved bonding material at the dosage of 6 KG/bag of cement under.

- **System:** Providing and Applying 1.5mm polyurethane membrane applied in one coats ,pure polyurethane based, single component, low VOC, elastomeric, seamless, waterproof membrane having following technical properties:
  - Elongation at break of 500-700% (ASTM D412-90)
  - Tensile strength (ASTM D412-90) >1.9 N/mm2
  - Adhesion-in-peel test (N) (ASTM C836)- >60,
  - Recovery from 350% elongation (%)(ASTM D412-90) -95 ,
  - Initial hardness (Shore A) (ASTM 2240-86)-65,
  - Water permeability (DIN 1048)-Zero
  - Tear resistance (ASTM D624-00) 21N,
  - Water vapour transmission for 2.3mm film-0.6,
  - Capable of bridging substrate cracks up to 2mm ,
  - Tack free time @ 25 °C-3hours,
  - Specific gravity-1.4, Solids content (%)-89,
  - Viscosity-160cps ,
  - Service temperature (continuous ambient) -40°C to 70°C
- when applied in one coats to achieve average WFT of 1.5 mm. Work shall be executed as by authorised Applicator .Application and methods shall be as per the manufacturer Specification
- Providing a Geotext fabric of 150GSM over the cured waterproofing membrane before going for a Protection Screed.
- Protection Layer (Horizontal) : Further laying protective concrete screed of average 75 mm using M20 grade concrete with minimum thickness of 40 mm at the rain water outlet and a slope of 1:120, making wattas at the junctions of horizontal and vertical surfaces to a float finish, well compacted, curing for 7 days etc. complete.(RMC with pump shall be provided by contractor free of cost at site).
- The concrete shall be exposed by cutting grooves of size 6mm(W) x35mm(D) by saw cutting into panels of size 2.5x 4mtrs, the grooves formed by exposing the concrete shall be filled with Polysulphide sealant, as per the manufacturer's Specification.

Expansion Joint:

- **Surface Preparation:** All surfaces shall be dry and free from frost, surface laitance and contamination. Surfaces should be free from cavities and projecting nibs.
- **Baker Rod:** Supply of Non Absorbent, rot proof, Compressible, Closed Cell polyethylene foam baker rod of 20mm core dia to be laid as per manufacturer's specification.
- **Coving:** Coving at the junction of slab and vertical offsets with CM 1:3 mixed with approved bonding material at the dosage of 6 KG/bag of cement under.

- **System: Polysulphide Sealant:**
  - Apply by brush and allow it to dry for minimum 20 minutes. Apply two coats of primer at an interval of 30 minutes. After priming is over, sealants should be filled after 30 minutes and before 90 minutes.
  - Sealant: Mixing the curing agent is to be poured in the tin with the base and mixed thoroughly with a slow speed electric mixer (300 to 450 rpm) for approximately 5-6 minutes until a homogeneous and uniformly grey coloured material is obtained.
  - Applying properly mixed Polysulphide based, joint sealant with in the Groove of 30mm X 15mm when the primer is tack free condition.
  - Standards compliance
  - ASTM C920-87, Type M, grade NS, Class 25.
  - IS12118 (PT 1&2) – 1987
  - British Standard BS:4254: 1983
- The Product should possess following Properties:
  - Storage life : 12 months in original containers in dry conditions within the range room temperatures
  - Solid content 100%
  - Flash point 65°C
  - Shore A Hardness (ASTM D 412), 16- 20;
  - Potlife Min 2hrs at 25°C
  - Tensile Strength at break, kg/cm2 (ASTM D 412), 3 – 5;
  - Elongation at break, (%) (ASTM D 412), 500 – 600;
  - Adhesion / Bond Strength, Kg/2.5 cm (BS 4254), 3 – 4;
  - Plastic deformation, % (BS 4254), 15;
  - Staining (BS 4254), No stain;
  - Movement Accommodation Factor 25 % for butt joints and 50 % for lap joints;
  - Specific gravity (Mix), kg/ ltr 1.6 - 1.65;
  - Setting time at 25°C (BS 4254), 18 Hrs;
  - Curing Time at 25°C Min 7 days;

Sunken Area Water Proofing:

- Surface Preparation: Surface to be free from frost, surface laitance and contamination free from loose aggregate or other sharp protrusions with fairly smooth finish for application of waterproof coating prime the surface with water.
- Bore Packing: Preparing the inside surface of core and PVC by roughening using suitable file to get better adhesion prior to packing works. Cleaning the surface by wire brushing followed water jet to remove any laitance or loose flaky particles. Providing necessary

formwork for packing the bore using suitable arrangement (depending upon site conditions). Applying a coat of styrene- butadiene based polymer coating using any approved brand to enhance adhesion between the packing material and other surfaces and Application of Bath seal Tape at the middle of over the pipe external side and Packing the gap using non-shrink cement polymer based using Micro concrete up to the surface of the bore whilst the polymer is in tacky state.

- Coving: Coving at the junction of slab and vertical offsets with CM 1:3 mixed with approved bonding material at the dosage of 6 KG/bag of cement under.
- Treating the Cracks, Construction Joints : Chase opening the Construction Joints by providing " U " groove, removing the dust and clean the designated area fill the prepared surface using Micro concrete completely as per the manufacturer's Instruction, following by providing chemical injection treatment in the form of pressure grouting to the cold joint by injecting cement slurry mixed with grout admixture @ 225 gms per bag of cement, in the required consistency through the pre fixed PVC
- nozzles in the 18 mm dia holes, fixing of PVC nozzles with instant plug and final cutting the projected nozzles and sealing off the PVC nozzles after the injection operation is over with Cement Mortar 1:3 admix with the bonding agent, non-shrink rapid setting mortar compound, finishing, curing etc. as per manufacturers specification and as directed.
- System: Supply & application of Acrylic polymer modified elastomeric waterproofing membrane coating .Mix the liquid ,powder & water as per the approve manufacturer specification to obtain a 1mm thick coating in 2 coats.
- **Properties:** Pot life: 30 min. at 270C, Mixed Density: 1.85-1.95 g/cc, Application temperature: Not less than 10°C, Toxicity: Non-toxic ,Adhesion to concrete : >1N/mm2, resist positive hydrostatic pressure up to 7 meter head.

Tile Adhesive:

- Surface Preparation: Tile Adhesive can be applied directly on concrete screeds, Lean Concrete and cement or lime mortar which is admixed with water proofing compound at 200ml / Bag of cement. Special attention must be given to new construction prior to commencing tiling. Tiles should not be placed on concrete or brickwork until all shrinkage movement has taken place.
- System-: Providing and Applying Polymer modified tile adhesive mixed with clear potable water in the ratio 4:1 by volume (4 part powder : 1 part water). Add powder to water and mix until a uniform, lump free consistency is achieved. The total quantity of water may be slightly adjusted to achieve the required consistency. Application of adhesive should be spread on the substrate to a uniform thickness of 3mm, and then combed horizontally with a serrated trowel. Place tiles firmly into adhesive bed, ensuring good contact with a

twisting motion. Only apply to areas which can be tiled in the adhesive's open wet time (up to 1m2 at a time). The adhesive Shall confirm to IS 15477 Type I & II. Supply mixing and Application shall be as per manufacturer's Current data sheet.

- Tile Spacer Epoxy Grout: Providing and applying tile mate as per the manufacturers Current Data Sheet.
  - for tile size 300mm x 300mm 7mm thick, 2 mm joint filling
  - for tile size 200mm x 300mm 7mm thick, 2 mm joint filling
- Tile Spacer white cement Grout: Providing tile mate for filling joints in floor and wall tiles, internal/external applications of suitable colour, applied as per the manufacturers Current Data Sheet.
  - for tile size 300mm x 300mm, 3 mm joint filling
  - for tile size 200mm x 300mm, 3 mm joint filling
  - for tile size 300mm x 300mm, 4 mm joint filling
  - for tile size 200mm x 300mm, 4 mm joint filling

Cement Concrete Tile:

Supplying, fitting and fixing in position 25mm thick cement concrete tile of Ultra category-1/Eurocon or equivalent type of approved make, quality, colour and size in all floors at all height on 20mm thick bed of cement mortar of mix (1:4) laid in proper slope and gradient grouted with neat white cement slurry with required quantities of pigments of approved marks watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work complete in all respect as directed by the Engineer-in charge.

Vitrified Tile Flooring:

Providing laying and fixing of vitrified tile flooring using double charged (either heavy duty or glazed as per the schedule of finish) vitrified tiles of premium grade of approved make having thick of 10 to 12 mm conforming to IS 13756 of 800mmx800mm/ 600mmx600mm coloured / digitally printed series (homogeneous) of approved quality, colour in all floors at all height with tile adhesive on bed of cement mortar of mix (1:4) laid in proper slope and gradient with screened and washed sharp sand for mortar and grouted with epoxy grout with required quantities of pigments of approved marks to match the shades of the vitrified tile if required; watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work, complete in all respect as per specification and direction of Engineer-in charge. The transition with other materials like carpet/ granite etc. to be provided with standard profile systems (either aluminium or wood or stainless steel) as per the best practise in managing the level difference if any.

Vitrified Tile Skirting:

Supplying, fitting and fixing of double charged vitrified tiles in skirting of premium grade of approved make conforming to IS 13756 of 800mmx800mm /600mmx600mm coloured / digitally printed series (homogeneous) of approved quality, colour and size in skirting / dadoes in all floors at all heights using tile adhesive and minimum 12mm thick screened and washed sharp sand for mortar with grouted Epoxy grout to match the shade of the tiles including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, curing-sundries and T&P, etc. required for the work complete as per specification and direction of Engineer-in-charge.

Vitrified Tile wall cladding:

Supplying, fitting and fixing of double charged vitrified tiles in skirting of premium grade of approved make conforming to IS 13756 of 800mmx800mm /600mmx600mm coloured / digitally printed series (homogeneous) of approved quality, colour and size in skirting / dadoes in all floors at all heights using tile adhesive and minimum 12mm thick screened and washed sharp sand for mortar with grouted Epoxy grout to match the shade of the tiles including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, curing-sundries and T&P, etc. required for the work complete as per specification and direction of Engineer-in-charge.

Antiskid floor Tile:

Providing 30cmx30cmsize special anti skid rectified floor tiles of premium grade of approved make (to be applied mainly in toilet and bathroom areas)having minimum thickness 8mm having water absorption E>10%,modulus of rapture >15 n/sqm and breaking strength >600N of approved quality, colour and size in all floors at all height with tile adhesive on bed of cement mortar of mix (1:4) laid in proper slope and gradient, grouted with neat white cement slurry jointing the tile with neat white cement slurry mixed with required quantities of pigments of approved marks to match the shades of the ceramic tile if required, watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work, complete in all respect as directed by the Engineer-in-charge.

Granite Flooring:

Providing 18 mm to 20mm thick avg. granite flooring (type of finish required as/use like flame or honed finish or polished as per approved sample by the Architect/Engineer in charge) in staircases and lobby area of approved quality, colour and size in floors, treads and risers on steps (single piece) and landings in all floors at all height on minimum 25mm thick cement mortar of mix (1:1) laid in proper slope and gradient with screened and washed sharp sand for mortar and grouted with neat white cement slurry jointing the stone with neat white cement slurry mixed with

required quantities of pigments of approved marks to match the shades of the granite tile if required watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work including rubbing mechanically and wax polishing etc. complete in all respect as per specification and direction of Engineer-in-charge.

Static Tile in electronic equipment areas:-

Anti static conductive Type: (Surface Resistance below 1 Mega Ohm)

Anti static tiles are also used for server rooms, computer rooms & electronic equipment rooms where static electricity can damage the working of electronic equipment.

Features	Advantages	Benefits
Surface Electrical Resistance- Conductive <1 Mega Ohm & Dissipative – 1 Mega Ohm to 1 Giga OhM	Surface Electrical Resistance being the property of material decides the nature of product in terms of its charge conductance. Surface Electrical Resistance as per ANSI norms ensures smooth transfer of accumulated static charge to grounding path.	Static hazard free area resulting in smooth uninterrupted functioning of critical equipments. Helps in mitigating fire hazard from floor due to static charges.
Static decay time- Conductive- <0.5 Sec Dissipative- <0.5 Sec	Static decay time as per ANSI norms ensures smooth discharge of accumulated static electricity from the surface.	Compliance with critical requirement of such sensitive areas. Static hazard free area resulting in smooth uninterrupted functioning of critical equipments. Helps in mitigating fire hazard from floor due to static charges.

Firm and Effective Grounding of Floors	Vitrified anti-static tiles should help provide firm and permanent grounding	Assures anti-static property throughout the service life of product.
60cm X 60cm Matt finish AS Blue Tile	Bigger Size offers lesser joints. Matt finish with anti-skid elegant floor in blue shade.	Should meet industrial safety norms along with excellent aesthetic ambience.
Stain Resistance	Provides sufficiently good stain resistance property to effective maintain the matt finish floor. Being a glazed vitrified tile, the tile is virtually stain proof.	Helps in maintaining good housekeeping norms.

Sal Wood Frame:

Providing and fixing in position well dressed, naturally seasoned sal wood rebated frames of size 125mmx63mm to doors including two coats of hot bitumen applied to rear of frame in contact with masonry or concrete surface fixed with MS hold fast of 35x5mm embedded in cement concrete blocks 15x10x10cm of 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20mm nominal size) complete with all materials, labours, T & P including cost, conveyance, loading, sundries required for the work etc. complete in all respect as directed by the Engineer-in-charge.

Hard core Flush Door:

Supplying fitting and fixing in position 35mm thick flush door including lamination of Greenply/Mayur/Century/Kitply or equivalent type of approved make with teak wood beading and 1mm thick sunmica mechanically hot pressed to both side including fixing of fixtures like Godrej make Mortise lock having model no 9168, Godrej make Door closure heavy duty type having model no 8340, 125mm aluminium hinges, handle, tower bolt, stopper including cost of all materials, labour, all taxes, transportation, loading & unloading etc. complete as per specification and direction of Engineer -in-charge.

Teak wood Shutter:

Supplying, fitting and fixing in position 38 mm thick decorative Teak wood shutter 38mm style and 22mm to 25mm thick panel well-seasoned and well-dressed fitted and fixed to sal wood choukaths in all floors at all heights including providing ornamental design as per approved drawing with necessary beadings, cutting grooves in choukaths and for lapping portion of shutter where necessary, including fitting and fixing of Godrej make Mortise lock having model no 9168, Godrej make Door closure heavy duty type having model no 8340, 125mm brass hinges, handle, tower bolt, stopper including cost of all materials, labour, all taxes, transportation, loading & unloading etc. complete as per specification and direction of Engineer -in-charge.

Aluminium Door & Window:

Providing & fixing of DOMAL - 40 or equivalent Aluminium Building Systems, made from 6063 T-6 alloy and tempered euro groove aluminium profile, in approved surface coating, mechanically mitered & joined with corrosion resistance DOMAL accessories and hardware. Glass infill, of desired thickness, shall be fixed onto using non-aging siliconized microwave treated DOMAL gaskets depending upon on the structural conditions, functions and statistical load requirements.

Structural Glazing:

Providing & Fixing thermetically sealed insulating Heat reflective transoms & sub frame confirming to Griha guidelines (No aluminium section to be exposed to outside and only glass panels with silicon joint to be visible from outside) made of specially designed extruded aluminium section of Jindal / Hindalco/ OEL(Alom) make conforming to 6063 T5 or T6 as per B.S.1474, duly anodized / powder coated in approved colour & shade with mullions fixed to RCC beams/columns through adequately designed MS back up materials and Anchor fasteners of Hilti / Fischer make, having toughened glass on outer face plus 12mm air gap with perforated aluminium spacer bar and 6 mm clear float toughened glass on inner face (DGU) of Saint Gobain / AIS make (thickness and specification of glass should satisfy the detail design of the HVAC requirement with specific LT and SHGC with approved shade/tint) including providing EPDM gasket, silicon sealants etc. Glass to be fixed with structural silicone of Dow Corning/GE /JL/Alstone make & Norton tape, with weather sealant in silicone of Dow Corning/GE /JL/Alstone make & Norton tape, with weather sealant in between the joint to make leak proof glazing etc complete as per the approved drawing and direction of Engineer-in-charge.

Sensor Door:

Providing and installation of DORMA ES200 easy OPERATOR: Providing Dorma ES 200 or equivalent easy bi parting sliding door (Size - as per drawing) operator with 12mm thick toughened clear glass shutters, anchor fastener, BR soft nose seal, modular design, including internal cover

with operator, microprocessor control, self learning, reversing when obstruction is encountered. Microprocessor-controlled; control unit with adjustable parameters for opening and closing speed, hold open time and opening and closing force. Class of protection 20. The system shall have constant power supply 230V, 50/60Hz, UPS supply for various opening sizes all complete as per design. ES 200 is TUV type tested, compliant EU Low voltage directives, production according to ISO 9001 certification type B. The cost including conveyance, loading, unloading, royalties and taxes of all materials, curing-sundries and T&P, etc. required for the work complete as per specification and direction of Engineer-in-charge.

Glass Partition:

Supplying and fixing of manually operated 12mm thick toughened glass partition cum door including floor spring of requisite weight (floor plate fixed flush with floor) lock (DORMA Cat. no. Agile 150 or equivalent), handles & screws etc. (DORMA or Equivalent) including all labour charges for fixing and all applicable taxes etc., and as per approved drawing of the Architect / consultant and as directed by Engineer-in-charge.

PVC Door & Frame:

Providing and fixing factory made PVC door frame of size 50x47mm with a wall thickness of 5mm rigid PVC foam sheet, mitred at corners and jointed with 2 nos of 150mm long brackets of 15x15mm MS square tube, the vertical door frame profiles to be reinforced with 19x19mm square tube of 19 gauges. The door frame to be fixed to the wall using MS screws of 65/100mm size. PVC door shutter consisting of frame made out of MS tubes of 19-gauge thickness and size of 19x19mm for style and 15x15mm for top and bottom rails. MS frame shall have a coat of steel primers of approved make and manufacture. MS frame covered with 5mm thick heat moulded PVC C channel of size 30mmthickness, 70mm width out of which 50mm shall be flat and 20mm shall be tapered in 45-degree angle on both side forming styles and 5mm thick, 95mm wide PVC sheet out of which 75mm shall be flat and 20mm shall be tapered in 45 degree on the inner side to form top and bottom rail and 115mm wide PVC sheet out of which 75mm shall be flat and 20mm shall be tapered on both sides to form lock rail. Top bottom and lock rails shall be provided with both side of panel 10mm (5mmx2) thick, 20mm wide cross PVC sheet be provided as gap insert for top rail and bottom rail. Panelling of 5mm thick of both side PVC sheet to be fitted in MS frame welded/sealed to the styles and rails with 7mm (5mm+2mm) thick x 15mm wide PVC sheet beading on inner side and joined together with solvent cement adhesive. An additional 5mm thick PVC strip of 20 mm width is to be stock on the interior side of the channel using PVC solvent adhesive etc complete as per direction of Engineer-in-charge.

Wood Polymer Composite Door

Raw materials

Natural fibers: wood waste, saw mill waste, wood powder, wood flour, wood chips, bagasse, bamboo, coir fibers, rice husk, cotton stalks

Polymers: PVC virgin and PVC recycled

WPC Profile Door material density: 650 Kg/m3 to 800 Kg/m3

Door Frame size – 50 x 125mm

Thickness of door panel – 30mm

Work description:

Supply of WPC door frame of size 50 x 125mm of required length and width, fixing on brick/RCC surface with 6 nos anchor fastener (3 nos each side) including stainless steel screw.

Supply of 30mm thick WPC door panels of required width and height, fixing with WPC door frame by fixing of 3 nos 6 inch stainless steel hinges. The door panel shall be provided with two 25 x 125mm bright finished stainless steel handle (One on front and another on back side) and three nos 200mm bright finished stainless steel tower bolt (one on front side, one on back side horizontal and one on back side vertical top) and all required locking arrangements.

Cupboard Shutter:

Supplying of full height or low height storage (as per approved drawing) made out of 18mm pre-laminated board with two side panel & a back panel (9mm). It should be a 25-mm edge banding top. The storage should be provided with shutters mounted on to the cabinets by full overlay auto shut hinges. It should be provided internal sleeves for storage. It should be provided with proper handles. All exposed edges should be mechanically edge banded by PVC tape (Rehau & Dolkan) and hot melt glue. It should have knockdown arrangement for fitting and provided with plinth adjuster on the bottom. All hardware fittings will be of Hettich make or equivalent.

Stainless Steel Railing:

Supplying, Fitting and fixing of stainless steel of 304 grade in hand railing using 50mm dia of 2mm thick circular pipe with Balustrade of size 50mm dia of 2mm thick @ not more than 0.90mtr C/C (spaced equally as per site) and stainless pipe bracing of size 32mm dia of 2mm thick in 3 rows in stair case all in satin finish as per approved design and specification buffing polishing etc with

cost conveyance taxes of all materials labour T&P etc required for the complete in all respect and as per the direction of Engineer -in-charge.

Paver Block:

Supplying and laying of M40 grade heavy duty factory made hydraulically pressed and mechanically compacted free cast interlocking TUFF STONE brand pavers of 80mm thick, coral shaped or as per approved design along with preparation of sub base with 50mm sand and levelling, laying of interlocking paver block with sand binding and final compaction with plate vibrator finishing the surface including cutting of blocks at the edges with all labour and materials etc complete as per direction of Engineer-in charge.

GRC Customized Screens casted with Power Spray methodology:

Providing and fixing Glass Reinforced Concrete (G.R.C) Screens in approved size, pattern, design, shade and thickness of 50mm on frame and design element in 30mm thick casted with layering technique Power Spray methodology have weight approximately between 3.5 – 4 Kg per Sq. Ft. and colour of M/S UniStone make or equivalent. The above weight and thickness is considering dimensions of screens up to 2133mm in height and 1219mm in width and having at least 50% void space. The screens should be made from '53 grade' White Portland Cement manufactured by 'JK Cement' or equivalent, Fine graded Quartz & Silica Sand, Alkali Resistant Glass Fibre manufactured by 'N.E.G JAPAN' or equivalent, Super Plasticizers manufactured by 'ZPXRC' or equivalent, Polymers manufactured by 'Dow Chemicals' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation manufactured by Lanxess / 'BAYFERROX (Germany)' or equivalent. The material casting should take place in FRP Moulds. The fixing of Screens should be 'Dry fixing' i.e. to be done with M.S Galvanized Clamps, fixtures and fasteners of Hilti / Fischer or self - tapping screws. All applicable taxes shall be charged extra, as per actual. All transportation cost shall be charged extra, at time of dispatch of material from plant premises.

Acoustic wall cladding:

Providing and fixing 9mm polyester fibre acoustic NSA Pet panel of size 2440 x 1220 x 9mm glued to 6mm ply fixed to GI frame. SG GI frame fabricated with 50 x 50mm sal wood spacers at 600mm, 50 x 32 x 0.55 floor and ceiling section at top and bottom edges, 48x36x34x.55 stud section at 600c/c vertically, 80 x 26..5 ceiling section at 300c/c horizontally. 16gGI wire mesh stretched and fixed to entire back face of the GI frame to hold Cine view welding in place 1000gsm/50mm wadding to be fitted in GI. 9mm polyester fibre acoustic pet panel to have 25 (A) grade fire resistance by ASTM-E4. Panel design (in colours & pattern) to be created as per approved layout/ design subjected to the approval of engineer in charge.

Gypsum wall partition:

Providing and laying gypsum panel partitions 100mm thick with water proof gypsum panels of size 666 X 500 X 100 mm, made of calcite phosphor Gypsum fixed with tongue and groove, jointed with paper tape joint and bonding plaster as per manufacturer's specifications in super-structure above plinth level up to floor V level complete with cut-outs for cables / electrical switch plates etc.. Gypsum blocks will have a minimum compressive strength of 9.3 kg/ cm2.

Backlit SS Signage's:

Design, manufacturing & installation of backlit signage's where all the letters in Signage will be illuminated by energy efficient LEDs having a lamp life of minimum 50 - 70000 hrs and will have approximately 7 times more Light output than Conventional Signage. The signage will have very strong and uniform illumination throughout the Graphics and logo with no HOT SPOTS Visible the Illumination will be Edge to Edge. LEDs for external application shall be protected by Green Compound System, Temperature 300' F, UV rays, Ozone & weatherproof. All wiring & connections will be of international standard with no joints between two points. LED light sources (imported Interone Led Modules & Converters) are small and unobtrusive, easy to install, and can generally be fitted out of sight. The letters will be of SS 18 gauge with 3M Vinyl face using branded ISI marked L.T wire and branded fasters for wall mounting. Colour of vinyl & light will be as per approved design & sample and to be constructed after the approved shop drawing and finished to the best standard.

GRC jali:

Providing and fixing Glass Reinforced Concrete (G.R.C) Screens in approved size, pattern, design, shade and thickness of 50mm on frame and design element in 30mm thick casted with layering technique Power Spray methodology have weight approximately between 3.5 – 4 Kg per Sq. Ft. and colour of M/S UniStone make or equivalent. The above weight and thickness is considering dimensions of screens up to 2133mm in height and 1219mm in width and having at least 50% void space. The screens should be made from '53 grade' White Portland Cement manufactured by 'JK Cement' or equivalent, Fine graded Quartz & Silica Sand, Alkali

Resistant Glass Fibre manufactured by 'N.E.G JAPAN' or equivalent, Super Plasticizers manufactured by 'ZPXRC' or equivalent, Polymers manufactured by 'Dow Chemicals' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation manufactured by Lanxess / 'BAYFERROX (Germany)' or equivalent. The material casting should take place in FRP Moulds. The fixing of Screens should be 'Dry fixing' i.e. to be done with M.S Galvanized Clamps, fixtures and fasteners of Hilti / Fischer or self - tapping screws. The fixing of

Screens should be 'Dry fixing' i.e. to be done with MS/SS 'L' shaped Clamps, dash fasteners and pins etc as per site requirement.

External stone cladding(dry cladding)-

Providing and fixing for dry cladding with 30 mm thick gang saw cut(Agra red or equivalent) with machine cut edges sand stone on walls at all heights using S S 304 Bracket in the required pattern as per architectural drawing, including cost of cutting, Fixing etc. Embedded in brick wall with cement concrete block 1:2:4 approved expansion hold fasteners on CC/RCC surface, including drilling necessary holes. Approved cramps/ pins etc. support stone cladding, the SS 304 Bracket (Make hilti or Equivalent) as approved by Engineering- charge Shop drawings shall be submitted by the contractor to the Engineer-in-charge for approval before execution.

Providing and fixing adjustable 304 stainless steel cramps & 10x100 SS 316 Anchor of approved quality, required shape and size, adjustable with stainless steel nuts, bolts and washer (total weight not less than 260 gms- Make HILTI/ FISCHER), for dry stone cladding fixed on frame work at suitable location, including making necessary recesses in stone slab, drilling required holes etc complete as per direction of the Engineer-in-charge

Exposed brick work and brick jali-

Erecting exposed brickwork and brick jali where the facing brick should be machine moulded made od suitable soils shall be free from cracks,flaws, free of lime wrapage and organic matters. these shall be throughly burnt and shall have plane rectangular faces with parallel sides and sharp straight edges. The joints shally be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The make should be Pioneer / Jindal or equivalent.

Exterior texture plaster or paint

Finishing the exterior wall with texture finish plaster made up of acrylic co polymer resins combined with quartz silica, mineral aggregate, synthetic inorganic pigment and all to give a feel of real stone or any other natural texture to be applied on smooth plaster or concerte surface with minimum thickness 0.75 mm.

Metal Roof sheeting with under-deck Insulation:

Providing & fixing weld mesh 50 x 50 x 1.6mm to the purlins and create a bed, placing Rockloyd Rockwool Slabs of density 48kg/m3 and thickness 50mm conforming to IS: 8183 with aluminum foil lamination on the facing side over the metal mesh bed and held in position by tying GI wire crisscross through the cleats.

Providing and fixing permanently color coated profile Lloyd Standing Seam profile sheet or equivalent manufactured out of 0.55 mm TCT (Total Coated Thickness) Galvalume steel (150 gsm. zinc - aluminum alloy coating total of both sides as per AS 1397: 1993) having min.300 Mpa yield strength. The color coating shall comprise of Silicon Modified Paint. The color coating

shall comprise of 20 microns finish coat over a 5 micron primer coat on the exposed side and back coat of 5 microns over a primer coat of 5 micron on the reverse side. The sheet shall be standing seam profiled having max. crest height of 63mm at min.418mm pitch distance fixed over a unique concealed clip made from 1.5mm GI which is locked together by a mechanical zipping machine to give absolutely puncture less roof and prevent leakage and shall be profiled at site with suitable fasteners. The work shall be carried out as per specifications, approved drawings and instruction of the Engineer-in-charge. The Profile steel sheets shall conform to IS: 513, 277 & 14246.The sheet & insulation to be manufactured and erected by an ISO: 9001 certified company. Taxes will be paid extra. Scaffolding charges will be paid as per the current rate.

Carpet:

Style	T655 “Pigment” Carpet Tile
Construction	Hi/Mid/Lo Loop
Pile Fiber	nexlon™ with Tuntex Approved Nylon with Anti Stain & Soil Treatment
Tufted Machine Gauge	1/12 gauge
Pile Weight	680 gm/m2
Pile Height	6.0/5.3/3.0 mm
Total Thickness	9.2 mm max
Tile size	500mm x 500mm
Total Weight	5050 gm/m2
Secondary Back	Recyclable Tuntex Commercial Duraback
Wear Warranty	Lifetime – product is warranted not to lose more than 10% pile fiber by weight in normal commercial use
Color Fastness	15 Year Warranty ASTM 16-04. Grade 4 – Little or no change
Static Electricity	Permanent Lifetime Protection – less than 3.5kv
Stain Resistance	nexlon™ Stain Shield Treatment
Soil Resistance	nexlon™ Soil Guard Treatment
Flammability	ASTM E-648 Radiant Panel Class 1

Dimensional stability warranted not to change in size by more than 0.5mm in normal use. Will not dome or dish in normal use

Installation Pressure Sensitive Adhesive

Sustainability All yarns used shall be Solution dyed to minimize use of water and exclude any effluent production ISO 14001 and ISO 9001

METAL FALSE CEILING

Providing and fixing non perforated aluminium modular tile ceiling, comprising of 600 mm x 600 mm x 0.6 mm thick aluminium un-perforated tiles, the tile ends to be raised with pipes and stops to ensure positive engagement into the spring to enable for demounting of individual tiles, side of the tiles to be sufficiently raised to insure a minimal deflection across the length of the tile. All tiles to have edges to be compatible with silhouette or equivalent grid. Tiles to be polyester based powder coated in white colour. The tiles to be clipped into clip profile of 0.5 mm thick gi clip. The clip profile shell be supported from structural slab by means of rigid suspension of 4 mm gi rod, hold on clamp with clip for level adjustments. Some tiles to be replaced by ventilation grills/ light fixtures, but not supported from the grid joints of the main tee.

MICRO PERFORATED GYPSUM PLASTER BOARD FALSE CEILING

Supply and installation of gfr grade micro perforated gypsum plaster board for acqustical treatment of size 600 mm x 600 mm x 12.5 mm thick in profile along with necessary fixing arrangemnets.

Hi-pressure laminate:

Supply and Installation of 6mm thick Exterior grade F- Quality panels of standard size with both side decor.

Max Exterior panels are duromer high-pressure laminates (HPL) as per EN 438-6, type EDF manufactured using patented Technology (NT); Panels are double hardened including acrylic polyurethane resin which is thermally cured under high pressure.

Explanation NT: Non fading high performance acrylic polyurethane surface Technology.

Installation of panels for Facades above 15 meters height and for wind loads above 1.2 kpa will be done by MBE Rivets (with Fixed and Sliding Points) with recommended Aluminum LT1 series, T1 section of 100x50x2 mm thick and L1 section 50x50x2mm thick held by Wall Bracket with Wind load and Dead load slot as per design, anchored by standard Hilti/Fischer or equivalent make anchor fasteners along with Thermal Separator

Installation of Max Exterior panels for facades below 15 meters and for wind loads below 1.2 kpa, and also soffits, will be done by MBE Rivets (with Fixed and Sliding Points) with minimum recommended LT2 series, Aluminium T2 section of 75x37x2.8 mm thick and L2 section

30x30x2.8mm thick held by Wall Bracket with Wind load and Dead load slot as per design, anchored by standard Hilti/Fischer or equivalent make anchor fasteners along with Thermal Separator. Installation of Panels will be done using Rear Ventilated Principles only, which is ensured by providing ventilation gap minimum 200 cm2/ per Meter (for free flow of air behind the façade) for the façade and using the framework with no horizontal section.

Properties	Test method	Unit of measurement	Standard values
Overall Thickness		mm	6
Apparent density	EN ISO 1183-1	g/cm³	1.35
Flexural Strength	EN ISO 178	MPa	≥ 80
Modulus of Elasticity	EN ISO 178	MPa	≥ 9000
Tensile Strength	EN ISO 527-2	MPa	≥ 60
Co-efficient of Thermal Expansion	DIN 52328	1/K	$18x10^{-6}$
Fire behaviour Europe	EN 13501 -1	MA39 VFA Vienna	B-s2, d0 for 6mm

Wooden flooring:

Vintage Laminated Wooden Flooring, 12MM Thick AC-5

Engineered Wooden Flooring Area-1900*190*14/3MM

AUDITORIUM STAGE CURTAIN

Vertical up-lift Main Curtain System: The complete automatically motorized Uplifting curtain system operating fully automatic, Made out of Fire Ratadent Long Crush fabric have a lovely reflective look, usually with lots of fullness & with fixing steel rails track and can "fly in" and "fly out" thereby opening up the stage area by taking up on stage using MS pipe main shaft with 20 No. Mini drums, 18 No. Weights, curtains are gathered and rouged and hooked and corded at the back to make the principles of the vertical mechanism to work.& 4 No. Bearings on base frame supported on 1.5" MS square pipe ladder type Frame, to be fixed on top of mother-grid ; with 3-phase 2.0 HP motor (Godrej or Crompton Greaves) coupled with Greaves (premium) Modified Gear box, complete with Limit switches, Coupling, Pulleys & V-belt, 3mm steel wire 1 No. Custom Design wire rope, mounted on Ang. Iron base frame ; with air breaker contractors L&T/Siemens, micro switches for auto stop, 3 nos. push buttons for Up, Down and Stop positions; c/w fitting as required with 300% drapping in closed position ; **Approx. Size:** as per actual __ft x __ft (including Cloth material approved by engineer incharge; c/w Motor mounting "C" channel platform.

FABRIC Type : CRUSH, SATAN & LONG CRUSH
Fabric Make : RAYMONDS, RELIANCE & TEXTILE PRO

Horizontal CENTRE CURTAIN: The complete automatically motorized Stage curtain system with additional modified Gearbox fitted with sealed bearings self-lubricating centre split overlapped curtains both sides opening fully automatic Stage Curtain fixing steel rails track, 620 GSM Fire Ratadent Fabric, double gathering Curtain cloth drapery horizontal sliding arrangement complete with fixing rails, brackets and motorized operation complete with runners, master runners, pullies, 3mm steel wire rope, 1 HP Motor (Crompton or Godrej) 2 Nos Air Breaker Contractors (L&T/SIEMENS), 2nos. Micro Switches for auto stop, 3 nos push buttons for forward. All rollers are sliding with roller clamp, The curtain should be half of full width operated from control panel with control switches. The Curtain should be draped to half area when in closed position. Minimum overlap at centre should be 900mm. The curtain should be stitched in double gathering with Provision for fully automatic operation only.

FABRIC Thickness: 620 GSM Fire Retardant
FABRIC SPECIFICATION: Velvet, Molfin or Hitech Fabric
Fabric Make : RAYMONDS, RELIANCE & TEXTILE PRO

Horizontal REAR CURTAIN: The complete automatically motorized Stage curtain system with additional modified Gearbox fitted with sealed bearings self-lubricating centre split overlapped curtains both sides opening fully automatic Stage Curtain fixing steel rails track, 620 GSM Fire Ratadent Fabric, double gathering Curtain cloth drapery horizontal sliding arrangement complete with fixing rails, brackets and motorized operation complete with runners, master runners, pullies, 3mm steel wire rope, 1 HP Motor (Crompton or Godrej) 2 Nos Air Breaker Contractors (L&T/SIEMENS), 2nos. Micro Switches for auto stop, 3 nos push buttons for forward. All rollers are sliding with roller clamp, The curtain should be half of full width operated from control panel with control switches. The Curtain should be draped to half area when in closed position. Minimum overlap at centre should be 900mm. The curtain should be stitched in double gathering with Provision for fully automatic operation only.
Size as per actual
FABRIC Thickness : 620 GSM Fire Retardant
FABRIC SPECIFICATION : Velvet, Molfin or Hitech Fabric
Fabric Make : RAYMONDS, RELIANCE & TEXTILE PRO

SITC of Data Signal Cabling for Control Panel with compatible wired Remotes: Supply, Installation, Laying, Testing & Commissioning of Data Signal Cabling for Remoter Curtains: Dual control of curtain operations one at stage and one in control room including control wiring Using 4-core PVC insulated multistranded cable to transmit Signal through curtain drives . high speed data cable designed for EIA485 ; lowcapacitance, twisted pair shielded ; FHDPE insulation, for interlinking splitter to Control Room with required connectors (1 main +1 backup) Providing and fixing control panel for with 4 x 1.5 sq.mm PVC copper cable as per IS fitted with control and indicators for Curtains installed on Stage.

STAGE FRILLS: made out of, 620 GSM double gathering glazed Velvet, Molfin, Mokel or Hitech Fabric; to be installed above the stage on 28mm dia GI pipe adjustable at position according to stage positioning plan; Cloth material of desired shade with Stitching.
FABRIC Thickness : 620 GSM Fire Retardant
FABRIC SPECIFICATION : Velvet, Molfin or Hitech Fabric
Fabric Make : RAYMONDS, RELIANCE & TEXTILE PRO

STAGE WINGS: Providing and fixing of cloth wings made out of black glazed 620 GSM Velvet, Molfin, Mokel or Hitech fabric fixed on the pipe framework made out of 25mm X 50mm 16G weilded rotatable tubelar frame fixed with overhead pivote track complete with duly painted on both framework Pivoted Rotatable Bar Fixed with 6mm thick commercial plywood fixed on one side of Frame work with sliding assembly on top supported from ecisting structure & wheels on bottom for free movement.
FABRIC Thickness : 620 GSM Fire Retardant
FABRIC SPECIFICATION : Velvet, Molfin or Hitech Fabric
Fabric Make : RAYMONDS, RELIANCE & TEXTILE PRO
Size : As per Actual

CYCLORAMA FRAME WITH 1.8 Power HIGH GAIN GRANDVIEW MATT WHITE PROJECTOR SCREEN: Cyclorama frame with Grandview high-gain matt white screen duly stretched on large tubular MS pipe frame made fix frame for projection screen: Cyclorama Screen that is manufactured using quality assured raw components and advanced technologies. Hi- Gain Cyclorama screen has been installed for Slide / film projection in a multipurpose auditorium, besides using it as colour wash or for pattern projection for stage performance. Cyclorama lights are directed to fall on this screen to colour wash it from top as well as Moving Heads installed on the First Intelligent Bar provide infinite pattern and depth to the screen. High-gain front projection screen with four inch black masking studs on all sides. HD fabric Material is designed for DLP

and LCD Cinema Projectors. This surface is the best choice when using a low contrast ratio projectors with a high definition video source. High Contrast is perfect for use in HD Cinema applications Screen Surface is safely washable with mild soap and water. The work shall be executive as per drawings , specification & instructions of engineer in charge.)Size : As per Standards)

Cable Trays:

Supplying and installing following size of perforated painted cable trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with M.S. suspenders including bolts & nuts, painting suspenders etc. as required of different sizes.

Size: As vendor

Cat Walk: A bridge fabricated from structural steel of 2.5"width and length according to the Auditorium for holding stage lights in front of stage, approach to cat walk is given from sides with help of ladder, lighting bar is fixed on the cat walk to hold the stage light and give focus on centre of stage, made from wooden planck or Plywood. The Work Shall be executive as per drawing s , Specification & instruction of engineer in charge.

Fabrication on Stage & Catwalk: 50mm dia B class GI pipe to be hung from existing grid or roof structure for side wings, lighting bars for holding entire fixtures with wire mash1" square 3ft width with flat & angle iron

Size : As per vendor & Standards

GRID STRUCTURE: Customized Fabrication of Main Overhead Grid over Stage using 40mm x 40mm x 5mm MS A Iron, in a 4ft.x2ft. Section & suspended from the ceiling Grid dimension. The Work Shall be executive as per drawing s , Specification & instruction of engineer in charge.

Size & Weight : As Per market

Push Back Auditorium Chair: Furnished With Red 575 GSM Molfin Fabric, Steel structure Heavy Gauge Synchronized Push Back Jerk Free Movement with Prime Steel Construction in powder coated finish, high density molded foam, Side Covered with Cup Holder Arm rest with PU Insert.

VIP Row Auditorium Chair: Soft and comfortable moulded foam with strong restoring functional Chair Very popular in VIP row seating Pushback chair with very stylish P.P handles and poly filled back. The back is filled with reckon fibre (polfill) which is indeed soft and comfortable, The base foam is P.U foam with 45 density

Ceiling acoustic:

Providing & Fixing of Ceres Fiber Acoustical Suspended Ceiling

System – CERES GLASS Micro look/Square EDGE TILES WITH 15mm Exposed Groove Grid. The tiles should have Humidity Resistance (RH) of 95%, NRC 0.90, Light Reflectance >84% with Fire Resistance in module size of 595 X 595 X 15 mm. 15mm grid sections i.e. the Main Runner 3000mm in 32 mm web height, 1200 mm & 600 mm Cross Tees in web height of 26mm with thickness 0.3mm. INSTALLATION: To comprise main runner spaced at 1200mm centre securely fixed to the structural soffit using suspension system at 1200mm maximum centre. The First/Last suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall. Flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre to form 1200 x 600 mm module. Cut cross tees longer than 600mm require independent support. 600 x 600mm module to be formed by fitting 600mm long flush fitting cross tees centrally between the 1200 mm cross tees. Perimeter trim to be wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres and as per the drawing and the work complete in all respects to the satisfaction of Engineer in-charge. SUSPENSION SYSTEM accessories consisting of HLC Sleeve Anchor Fasteners of thread size 6.5mm x 25/5 with Soffit Cleat made of Galvanised steel of size 27 x 37 x 25 x 1.6mm and Level Clip in dimensions of 85x30x0.8mm with 4.00 mm GI wire.

Wooden acoustic panel at stage :Providing & Fixing 20mm Thick Panels in Size 1220 X 610mm

Colored Panel as per desired Finish , Premium Square Edge.Panels are made of pine wood Fibers containing Cellulose Binded with Magnetite. The Paanels will be screw Fixed @ 200mm on GI Metal Frame of 50 X 50mm Making a grid of 610mm c/c. The Frame is to be made in proper line after leveling. The Panels will be backed with 50mm Roxul Rockwool of 48 kg/cum inserted inside the grid of 610 X 610mm Which will comprise of minimum NRC 0.80 as per IS: 8225/ ISO: 354/ASTM: 423-90a. The Panel meets the Stringent fire test required having Class 'P" rating for ignitability test as per BS 476 part 5 and class 'I' rating as per BS476 part 7 for surface spread of Flame test. Class 'P' and Class 'I' are the Highest rating .BS 476 part 6 fire Propagation index, I- not greater than 4.11. Panels Shall be Spray Painted with Choice Clour for Final Finish.

* Stage Ceiling - 233.08 Sq/M.
* Stage Side Walls (Right & Left) & Rear Wall - 462 Sq/M

Providing and fixing false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of

120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash

fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recomme-nded jointing compound , jointing tapes , finishing with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge but excluding the cost of painting with Stage . 12.5 mm thick tapered edge gypsum moisture resistant board is a moisture resistant gypsum board suitable for use in internal wet areas,

Painting with acrylic emulsion paint at all heights, having VOC (Volatile Organic Compound) of approved brand asian paints, and manufacture, including applying additional coats wherever required, to achieve even shade and colour.

WALL TREATMENT

Providing and fixing grooved panel having system NRC up to 0.75 with lineal perforation.

The Acoustical panels shall be fire resistance(FR) BS476 Part 7 with melamine laminate panels 2440mm x128mm x 15mm with 2mm groove at 14mm pitch, Tongue and Groove edges for seamless mounting having density of 800kg/m3(base panel confirming to IS 12406 and laminated panel confirming to IS 14587). The black of the panels are perforated with a nonwoven fabric covering of 0.2mm for providing Sound absorption via the acoustic impedance method. Acoustical Panel is fixed by using GI Framework spaced at 600mm centers @ aluminum framework spaced at 400mm centers with suitable brackets and the system is backline with 50 mm Roxul Rockwool and along with all accessories. Installation wooden battens (provided by others) of section

50mmx50mm or as approved by the Architect on the solid wall horizontally using screws and plugs at spacing of 600mm centre-to-centre. Screw the aluminum extruded keel for channeled woodworks provided by manufacture over the lowest and second wooden batten at an on- center distance of 600mm. Install the first set of wooden panels by inserting the clips for border channeled woodworks and insert the groove of the panel into the projecting flange of the aluminum clip. Continue installing rows of panels by inserting the tongue into the groove of the earlier inserted panel and progressively installing clips for inside channeled woodworks into the next keel till the actual height is achieved. Use clips for border channeled woodworks to finish off the installation. Finish off the edges using wooden moulding of matching color.

Providing and fixing of Fiber Glass Wall Panel of size 600 x 1200 x 25mm. The panels are manufactured from high density bio-soluble resin bonded glass wool absorber with a series of textile fabric, plain glass tissue backer and fabric wrapped edges. The Dexune Acoustic Wall Panels family provides a comprehensive tools to create a wide variety of wall panel designs - and still meet the strict requirements for first class acoustic. An extensive range of edge designs, forms and levels give you the freedom to create an environment that attains high standards in sound, colour, appearance, comfort and ambience

Technical Specifications:

Composition: Fiberglass panel with resin – hardened edges NRC : 0.90 - 1

Surface: Textile Fabric Environmental Influence: Fully recycled

Fire Reaction: Raw Material: Class A Facing fabric can be custom – ordered

Thermal Insulation: ≥ 0.5 (m^2 k / w)

Humidity: Max 90% RH at 40º C

Moisture Rate: ≤ 1% (JC/T670 – 2005)

Clean ability: Clean with vacuum, soft brush to remove residue

ACOUSTICAL WOODEN STAGE FLOORING: **Providing and Fixing Acoustical Wooden Stage Flooring** Compatible with Underground signal cabling and Pop-Up Boxes: Providing and fixing 65/75 X 18 thick in random length, 2nd class teak wood planks flooring with tongue and groove joints on a layer of 19 mm thick BWR grade ply of approved make and manufacture, fixed to hardwood joint 50 X 50 mm at 600 mm c/c in one direction and 60 X 50 mm Sal battens 600mm c/c on other direction, Hardwood joint resiliently supported on 100 X 100 mm Rubber Pads, the framework to be filled with 50mm thick Insulation Wool resin bonded insulation of density 24kg/cum. PU polishing of teakwood on the exposed surface: In horizontal/vertical plane (rate for flooring shall include providing additional framework required for housing microphone and power outlet junction - signal & Popup Stage boxes, If required providing and fixing hinged 18mm thick

teakwood cover for the junction boxes.Work complete in all Respect. The Work shall be executed as per drawings, Specifications & Instruction of engineer in charge.

ACOUSTICAL SOUND REDUCING DOORS: Providing & fixing Acoustical sound reducing Doors: Auditorium Acoustic Wooden doors are extremely high-performance sound reducing door sets. These high-quality door sets are available in a wide range of finishes with 3-Point Latching System. They are used wherever high sound reduction performance is required between noise sensitive areas. Leaf of the acoustic wooden door is made up of an acoustic sandwich panel core, hardwood or marine plywood structure with stripping in the recesses and on the bottom, surfaced on both sides with 2.5mm thick high-pressure laminate in the desired veneer over MDF board. The core of the door is made up of a sandwich panel of different materials in order to achieve good sound refraction and therefore good acoustic performance. The door to be fabricated with 12mm thick commercial ply (Green/so near or equivalent make) veneer facing and finished with varnish on both sides. wooden framework filled with Insulation wool with one layer of 80mm thick. 24.Kg.Cu.M density insulation wool. The insulation should be supported with wooden batten of kail wood framework minimum 610mm x 610mm to avoid sagging. The door leaf will be fabricated using 90mm X 70mm thick. Teakwood frame. The fixed door frame (chowkhat) shall be teakwood of size 150mm X 80mm. The door will have a hydraulic door closer, crossbar door handle and relevant hardware for fabrication and fixing. Complete with the requisite door frame and magnetic and rubberized door seals all around of the door frame or as per specification, drawing, and as per the instructions of Engineer-in- Charge. the door to be attached with the door frame by SS ball bearing hinges with adequate strength and numbers to avoid sagging All joints to be sealed with Dow Corning 790 or equivalent mastic Sealant. The doors on the auditorium side to be finished using non-light reflective media like a carpet of dull laminate /veneer. Heavy Duty Hinges with Ball Bearings, Door Handles, Long Tower bolts, Sliding Door boltswith Door Closures till 100Kg weight Capacity Stainless Steel Accesory shouls be used, The Work shall be executed as per drawings, Specifications & Instruction of engineer in charge.

Properties:

» Doors are supplied complete with their own mounting frames

» Adjustable Soundproof Jambs & Seals

» Infill Material : Insulation wool

» Best Performance Wood Finished Door Assembly

» Heavy Duty Hinges (4)

» 3-Point Latching System

Auditorium flooring:

Woven vinyl floorings

Providing and fixing of Sound Absorbent Anti bacterial Woven vinyl floorings with roll dimensions of 1.8 meters width and length of 20 meters with Stain, water & Oil resistant Tiles size as per company standard with self levelling adhesive should be approved by engineer in charge. 2.50-2.80 mm thickness to laid on hard, levelled, smooth and moisture free sub floor. Woven Vinyl flooring should have traffic classification 33 and weight of 2.7-3.5 kg/m2. Flooring should have caster chair EN-985 tested with colour fastness of more than 6. It should be ASTME662 qualified on Smoke density test. Product should be fire rating of the product should be Bfl-S1. Any Joints in flooring rolls should be sealed with cold welding. As per approved shade and colour as per the satisfaction of the engineer in charge

Stage Procenium Arc "Structure In Front Of Stage": **The proscenium** of a stage is one of the divisions of the stage, a structure in front of the stage that frames the action of the play. It can be square or arched, and the stage curtain is generally directly behind it."picture frame" placed around the front of an end stage. the invisible barrier that separates the stage from the audience and through which the audience watches the action. The “Arch acts like a picture frame through which the action can be seen. The picture above shows the Proscenium Arch of the Stage. A proscenium arch creates a "window" around the scenery and performers, the advantages are that it gives everyone in the audience a good view because the performers need only focus on one direction rather than continually moving around the stage to give a good view from all sides.

A proscenium theatre layout also simplifies the hiding and obscuring of objects from the audience's view. Anything that is not meant to be seen is simply placed outside the "window" created by the proscenium arch, either in the wings or in the fly space above the stage. Arch serves as the frame into which the audience observes from a more or less unified angle the events taking place upon the stage during a theatrical performance.

Providing & fixing Stage Proescinium: to be fabricated on site made with 50X50mm MA tubular frame. infill in 48mmthick 40kg/cum density Rock wool insulation padding. fixing on 12mm Water Proof Ply. Finishing with 1mm sun mica Approved Make with Laminate. The Work shall be executed as per drawings, Specifications & Instruction of engineer in charge.

Specs and Scope for the kitchen

Kitchen on ground floor of the auditorium-

All necessary arrangmnts for cooking including kitchen platforms, adequate ventilation,exhaust and fire fighting system except the cooking equipments.

Rest of the kitchens-

Rest of the kitchens to be fully functional kitchens including all services and necessary arrangements as approved by the client/Consultant.

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
AUDITORIUM AND CONVENSION CENTER										
1	**GROUND FLOOR**									
i	WAITING AREA, RECEPTION, VIP ENTRY	Granite	Size suitable as/site	Granite up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	Frameless floor mounted Glass door with adequate hardware fittings	Structural Glazing	Plane gypsum ceiling	
ii	STAIRCASE	Granite	As per Riser and Tread	Granite up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr with Panic Bar	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
iii	DINNING AREA/CAFETERIA	Vitrified Tiles	600 x 600	Vitrified Tiles up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	WPC door As/per Specs	Structural Glazing	Combination of Plane gypsum ceiling and	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
									600X 600 gypsum ceiling	
iv	KITCHEN	kota stone	560X560	kota stone up to 100 mm & Vitrified Tile up to the Height of 2100 mm	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	600 x 600 metal false ceiling	
v	TOILET AREA	Anti-skid vitrified tile	300x300	-	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers	Combination of calcium silicate board and 600 X 600 calcium silicate ceiling	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
vi	STAGE	Wooden Flooring as/Specs	AS PER AVAILABILITY						Acoustical false ceiling as/Specs	
vii	VIP WAITING	Granite	As/Site or As directed by the Eng-in-Charge	Granite up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	Decorative WPC door as/Specs	Aluminium sliding window	Plain Gypsum Ceiling	
viii	ELECTRICAL ROOM	kota stone	560X560	kota stone up to 100 mm	White Wash	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	White wash	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
ix	CONVENTION HALL	Granite	Size suitable as/site and directed by Eng. In Charge	Granite up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	Decorative WPC door as/Specs	-	Armstrong Acoustical ceiling as/Specs.	
x	PANTRY	Anti-skid heavy duty tile as/Specs	300x300	Vitrified tile up to heigh 1500 mm	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	WPC DOOR as/Specs	Aluminium ventilator with louvers	Combination of calcium silicate board and 600 X 600 calcium silicate ceiling	Fix with tile adhesive

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
xi	AHU,	kota stone	560X560	kota stone up to 100 mm	White Wash	Up to CEILLING	MS air tight Door with fire rating 2hr	Aluminium louvers	White wash	The room should be properly sound insulated using 19 mm thk elastomeric nitrile rubber insulation
xii	GREEN ROOM	Granite Flooring	Size suitable as/site and directed by Eng. In Charge	Granite up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	WPC DOOR as/Specs	Aluminium ventilator with Aluminium Louvers	Combination of Plane gypsum ceiling and 600 X 600 gypsum ceiling	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
xiii	RAMP	Granite	As per slope	-	-	-	-	-	-	With Anti skid groove on floor and SS railing
xiii	AUDITORIUM SEATING	Carpet	AS/ SPECS	Carpet with skirting board	Acoustical treatment as/specs	As/Specs	As/Specs		Acoustical false ceiling as/specs	
2	**FIRST FLOOR**									
i	GUEST ROOM	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Decorative WPC Door as /specs	Aluminium sliding window	600X 600 gypsum ceiling	
ii	BALCONY SEATING	Carpet	AS/ SPECS	Carpet with skirting board	Acoustical treatment as/specs	As/Specs	As/Specs		Acoustical false ceiling as/specs	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
iii	OPEN TERRACE	Granite & GREEN ROOF	As/site	Granite	Acrylic Emulsion Paint	Up to CEILLING	Decorative WPC Door (weather proof)	Aluminium sliding window	OBD	
iv	RAMP	Granite	As per slope							With Anti skid groove on floor and SS railing
v	KITCHEN	kota stone	560X560	kota stone	Glazed vitrified wall tiles up to height 1500 mm and Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	OBD	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
vi	DINNING AREA	Granite	Suitable size as/site or as directed by Eng in charge	Granite	Acrylic Emulsion Paint	Up to CEILLING	Decorative WPC door as/Specs	Aluminium sliding window	600X 600 gypsum ceiling	
vii	TOILET AREA	Anti-skid heavy duty tile as/specs	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers	Combination of Plane calcium silicate ceiling & 600 X 600 calcium silicate ceiling	

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
viii	MAINTENANCE OFFICE	Vitrified tile	600x600	Vitrified tile up to 100 MM	Acrylic Emulsion Paint	Up to CEILLING	Hard core wooden Flush door	Aluminium sliding window	600X 600 gypsum ceiling	
ix	LAUNDRY AND HOUSE KEEPING	Kota stone	560X560	kota stone up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	Hard core wooden Flush door	Aluminium sliding window		
x	STORE	kota stone	560X560	kota stone	White Wash	Up to CEILLING	Hard core wooden Flush door	Aluminium sliding window	-	
xi	AHU	kota stone	560X560	kota stone	White wash	Up to CEILLING	Air tight MS Door with fire rating 2hr	Aluminium sliding window	-	The room should be properly sound insulated using 19/13 mm thk elastomeric nitrile

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
										rubber insulation
xii	TOILET AREA	Anti-skid heavy duty tile as/specs	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers	600 X 600 calcium slilicate ceiling	
xiii	STAIRCASE	Granite	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	With Anti skid groove onfloor & SS railing
3	**SECOND FLOOR**									

SCHEDULE OF FINISHES FOR AUDITORIUM & CONVENTION CENTRE										
SI NO	**FLOOR DETAIL DESCRIPTION**	**FLOORING**		**SKIRTING**	**CLADDING / WALL FINISH**		**DOOR / WINDOW**		**CEILING**	**REMARK**
		TILE / SLAB	**DIMENSION**		**PAINT / SLAB**	**DIMENSION**	**DOOR**	**WINDOW**		
i	Lobby and circulation space	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Decorative WPC door as/specs	Aluminium sliding window	Combination of plane gypsum ceiling and 600X 600 gypsum ceiling	
ii	PROJECTION ROOM	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	MS Door with Vision panel fire rating 2hr	Aluminium sliding window	Combination of plane gypsum ceiling and 600X 600 gypsum ceiling	
iii	STAIRCASE	Granite	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	With Anti skid groove onfloor & SS railing

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
1	GROUND FLOOR									
i	WAITING AND RECEPTION	Granite	Suitable as/site or As directed by the Eng. In charge	Granite UP TO 100 MM	Acrylic Emulsion Paint	Up to CEILLING	Floor mounted frame less glass door with adequate hardware fittings	Structural glazing	Plane gypsum ceiling	
ii	CAFETERIA	Granite	Suitable as/site or As directed by the Eng. In charge	Granite up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	WPC door as per Specs	-	Combination of Plane gypsum ceiling 600 x 600 gypsum grid ceiling	
iii	STAIRCASE 1	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire	BRICK JALI	OBD	Anti skid groove in tread &

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							rating 2hr and panic bar			SS railing
iv	STAIRCASE 2	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr and panic bar	BRICK JALI	OBD	Anti skid groove in tread & SS railing
v	TOILET AREA	Anti-skid vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers / brick jali	600 X 600 calcium silicate ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
vi	KITCHEN	Anti-skid vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	WPC door as/Specs	Aluminium sliding window with louvers	600 X 600 calcium silicate ceiling	
vii	CONFERENCE	Carpet tile	As per size of the manufacturer	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Floor mounted frame less glass door with adequate hardware fittings	Aluminium sliding window	Acoustical false ceiling as/specs	
viii	ICT ROOM	Kota stone	560 x 560	100mm high kota stone	Acrylic Emulsion Paint	Up to CEILLING	Hard core wooden flush door	-	600X 600 gypsum ceiling	
ix	ELECTRIC ROOM	Kota stone	550 x 550	100mm high kota stone	White wash	Up to CEILLING	MS Door with fire rating 2hr	-	OBD	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
x	CITIZEN SERVICE COUNTER	Granite	Suitable as/site or As directed by the Eng. In charge	Granite up to 100 mm.	Acrylic Emulsion Paint	Up to CEILLING	MS Door	Aluminium sliding window	600X 600 gypsum ceiling	
xi	AHU	Kota stone	550 x 550	100mm high kota stone	Acrylic Emulsion Paint	Up to CEILLING	Air tight MS Door with fire rating 2hr	Aluminium louvers / brick jali	White wash	The room should be properly sound insulated using 19/13 mm thk elastomeric nitrile rubber insulation
2	**FIRST FLOOR**									

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
i	STAIRCASE 1	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr with panic bar	BRICK JALI/Aluminium Louvers	OBD	Anti skid groove in tread & SS railing
ii	STAIRCASE 2	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr with panic bar	BRICK JALI/Aluminium Louvers	OBD	Anti skid groove in tread & SS railing
iii	OFFICE	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	MS Door with Vision panel fire rating 2hr	Aluminium sliding window	600X 600 gypsum ceiling	
iv	CABIN	Carpet tile	As/the manufacturer	Carpet tile with rubber	Acrylic Emulsion Paint	Up to CEILLING	Glass door with	Aluminium sliding window	600X 600 metal false ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
				wood skirting			aluminium Frame			
v	MEETING ROOM	Vitrified tile	600 X 600	Vitrified tile up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	WPC door	Aluminium sliding window	600X 600 gypsum ceiling	
vi	TOILET AREA	Anti-skid heavy duty vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	300x300	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers	Combination of Plane Gypsum ceiling & 600 X 600 calcium silicate ceiling	
vii	LOBBY AREA	Granite	Suitable as/site or Directed by the Eng. In Charge	Granite	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted glass doors with adequate Hardware fittings	Aluminium sliding window	Plane gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
viii	TRAINNING ROOM	Carpet time	As/size of manufacturer	Rubber wood up to 100 mm	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted glass doors with adequate Hardware fittings	Aluminium sliding window	Armstrong Acoustical ceiling panels	
ix	RACK ROOM	Anti-skid heavy duty vitrified tile	300 x 300	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Hard core wooden flush door	Aluminium louvers	600X 600 gypsum ceiling	
x	PANTRY	Anti-skid heavy duty vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	300x300	Hard core wooden flush roor	Aluminium ventilator with louvers	600 X 600 calcium silicate ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
xi	ADMIN BACK OFFICE	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	WPC door as/Specs	Aluminium sliding window	600X 600 gypsum ceiling	
xii	CEO CABIN	Carpet Tile	As/manufactures	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	600 X 600 metal ceiling	
xiii	PA TO CEO CABIN	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	WPC door	Aluminium sliding window	Plane Gypsum ceiling with 600X 600 gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
xiv	PA TO DY CEO	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	WPC door	Aluminium sliding window	Plane Gypsum ceiling with 600X 600 gypsum ceiling	
xv	DY CEO CABIN	Carpet Tile	As/manufactures	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	600 X 600 metal ceiling	
xvi	ELECTRIC ROOM	Kota stone	560 x 560	100mm high kota stone	White wash	Up to CEILLING	MS Door with fire rating 2hr	Aluminium louvers	White wash	
xvii	AHU	Kota stone	560 x 560	100mm high kota stone	White wash	Up to CEILLING	Air tight MS Door with	Aluminium louvers	White wash	The room should be

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							fire rating 2hr			properly sound insulated using 19/13 mm thk elastomeric nitrile rubber insulation
3	**SECOND FLOOR**									
i	BOARD ROOM	Carpet Tile	As/manufacturer	100mm high Rubber wood	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	600 X 600 metal ceiling	
ii	STAIRCASE 1	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire	BRICK JALI	OBD	Anti skid groove in

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							rating 2hr with panic bar			tread & SS railing
iii	VIP LOUNGE	Carpet Tile	As/manufacturer	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	600 X 600 metal ceiling	
iv	LOBBY AREA	Granite	Suitable as/site or Directed by the Eng. In Charge	Granite	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	Combination of plane & 600X 600 gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
v	TOILET AREA	Anti-skid heavy duty vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	300x300	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers	Combination of plane and 600 X 600 calcium silicate ceiling	
vi	BATTERY ROOM	Kota stone	560 x 560	100mm high kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium louvers	OBD	
vii	RACK ROOM	Anti-skid heavy duty vitrified tile	300x300	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Hard core wooden flush door	Aluminium louvers	600X 600 gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
viii	PANTRY	Anti-skid heavy duty vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	300x300	Hard core wooden flush door	Aluminium ventilator with louvers	Plane and 600 X 600 calcium silicate ceiling	
ix	SERVER ROOM	Kota stone	560 x 560	100mm high kota stone	DO	DO	MS Door with fire rating 2hr	Aluminium louvers	600X 600 gypsum ceiling	
x	MATERIAL HANDLING ROOM	Kota stone	560 x 560	100mm high kota stone	DO	DO	Hard core wooden flush door	Aluminium louvers	OBD	
xi	ELECTRICAL ROOM	Kota stone	560 x 560	100mm high kota stone	DO	DO	MS Door with fire rating 2hr	Aluminium louvers	OBD	
xii	AHU	Kota stone	560 x 560	100mm high kota stone	DO	DO	Air tight MS Door with fire rating 2hr	Aluminium louvers	OBD	The room should be properly sound

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
										insulated using 19/13 mm thk elastomeric nitrile rubber insulation
xiii	STAITRCASE 2	Granite	Suitable as/site or directed by The Eng in charge	Granite on landing	-	-	MS Door with vision panel fire rating 2hr	BRICK JALI	OBD	Anti skid groove in tread & SS railing
4	**THIRD FLOOR**									
i	BOARD ROOM	Carpet Tile	As/manufacturer	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate	Aluminium sliding window	600 X 600 metal ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							Hardware fittings			
ii	TELE CONFERENCE ROOM	Carpet Tile	As/manufacturer	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	600 X 600 metal ceiling	
iii	TOILET AREA	Anti-skid vitrified tile	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	300x300	PVC DOOR & WPC(Main door) with Powder coated MS louvers at bottom	Aluminium ventilator with louvers	Plane and 600 X 600 calcium silicate ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
iv	LOBBY AREA	Granite	Suitable as/site or directed by The Eng in charge	Granite	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted forested glass doors with adequate Hardware fittings	Aluminium sliding window	Plane gypsum ceiling	
v	STAIRCASE 1	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr with panic bar	BRICK JALI	OBD	Anti skid groove in tread & SS railing
vi	STAIRCASE 2	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr with panic bar	BRICK JALI	OBD	Anti skid groove in tread & SS railing
vii	STAIRCASE 3	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire	BRICK JALI	OBD	Anti skid groove in

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							rating 2hr with panic bar			tread & SS railing
viii	COMMAND AND CONTROL ROOM	Carpet Tile	As/manufacturer	Rubber wood	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	600 X 600 metal ceiling	
ix	ELECTRIC ROOM	Kota stone	560 x 560	100mm high kota stone	White wash	White wash	MS Door with fire rating 2hr	Aluminium louvers	White wash	
x	STORE	Kota stone	560 x 560	100mm high kota stone	White wash	White wash	Hard core wooden flush door	Aluminium louvers	White wash	
xi	AHU	Kota stone	550 x 550	100mm high kota stone	White wash	White wash	MS Door with fire rating 2hr	Aluminium louvers	White wash	The room should be properly sound insulated using 19/13 mm thk

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
										elastomeric nitrile rubber insulation
5	**FOURTH FLOOR**									
i	BOARD ROOM	Carpet Tile	As/manufacturer	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Floor mounted Frameless glass door with adequate hardware	Aluminium sliding window	600 X 600 metal ceiling	
ii	TELE CONFERENCE ROOM	Carpet Tile	As/manufacturer	Rubber wood skirting	Acrylic Emulsion Paint	Up to CEILLING	Floor mounted Frameless glass door with adequate hardware	Aluminium sliding window	600 X 600 metal ceiling	
iii	TOILET AREA	Anti-skid heavy duty	300x300	Vitrified tile	Vitrified wall tile up to false ceiling high.	450 x 600	PVC DOOR and WPC main door	Aluminium ventilator with louvers	600 X 600 and plane calcium	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
		vitrified tile			OBD above false ceiling		with ms powder coated louvers at bottom		silicate ceiling	
iv	MANAGER ROOM	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	WPC Door with Vision panel	Aluminium sliding window	600X 600 gypsum ceiling	
v	DISCUSSION ROOM	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	WPC Door with Vision panel	Aluminium sliding window	600X 600 gypsum ceiling	
vi	ELECTRICAL ROOM	Kota stone	560 x 560	100mm high kota stone	White wash	White wash	MS Door with fire rating 2hr	Aluminium louvers	OBD	
vii	BEM ROOM	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	MS Door with Vision panel fire rating 2hr	Aluminium sliding window	600X 600 gypsum ceiling	
viii	AHU ROOM	Kota stone	22mm thk kota	100mm high kota stone	DO	DO	Air tight MS Door with	Aluminium louvers	OBD	The room

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							fire rating 2hr			should be properly sound insulated using 19/13 mm thk elastomeric nitrile rubber insulation
ix	STAIRCASE 1	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr with panic bar	BRICK JALI	OBD	Anti skid groove in tread & SS railing
x	STAIRCASE 2	Granite	As per Riser and Tread	Granite on landing	-	-	MS Door with vision panel fire rating 2hr	BRICK JALI	OBD	Anti skid groove in tread & SS railing

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
COMMAND AND CONTROL CENTER										
							with panic bar			

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW		CEILING	Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW		
TRIBAL MUSEUM										
1	GROUND FLOOR									
i	TOILET -1	Anti-skid vitrified tile	300x300	NA	Vitrified wall tile up to false ceiling high. OBD above false ceiling	Vitrified wall tile up to false ceiling high. OBD above false ceiling	PVC DOOR and WPC main door with ms powder coated louvers at bottom	Aluminium ventilator with louvers	600 X 600 and plane calcium silicate ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
ii	TOILET -2	Anti-skid vitrified tile	300x301	NA	Vitrified wall tile up to false ceiling high. OBD above false ceiling	Vitrified wall tile up to false ceiling high. OBD above false ceiling	PVC DOOR and WPC main door with ms powder coated louvers at bottom	Aluminium ventilator with louvers	600 X 600 and plane calcium silicate ceiling	
iii	STAIRCASE -1	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
iv	STAIRCASE -2	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
v	STAIRCASE -3	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr	Aluminium louvers	OBD	Anti skid groove in tread & SS railing

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
vi	Store room	Kota stone	560x560	Kota Stone	Acrylic Emulsion Paint	Up to CEILLING	Flush door	Aluminium sliding window	OBD	
vii	AHU	Kota stone	560x560	Kota Stone	OBD	Up to CEILLING	Air tight MS Door with fire rating 2hr	Aluminium louvers	OBD	The room should be properly sound insulated using 19/13 mm thk elastomeric nitrile rubber insulation
viii	electrical room	Polished Kota stone	550x550	Kota Stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium louvers	White Wash	
ix	Souvenir Shop	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted frosted Glass door with adequate hardware	Aluminium sliding window	Plane gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
x	lobby; Reception & waiting area	Granite	as per site	Granite	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted frosted Glass door with adequate hardware	Aluminium sliding window	Plane gypsum ceiling	
xi	Tribal Hut	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	WPC door as/Specs	Aluminium sliding window	Plane gypsum ceiling	
xii	Office & cabin area	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted frosted Glass door with adequate hardware	Aluminium sliding window	Plane gypsum ceiling	
xiii	Corridors	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	-	-	600X 600 gypsum ceiling	
xiv	Display Area									

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
2	**FIRST FLOOR**									
i	TOILET 1	Anti-skid vitrified tile	300x300	NA	Vitrified wall tile up to false ceiling high. OBD above false ceiling	Vitrified wall tile up to false ceiling high. OBD above false ceiling	PVC DOOR and WPC main door with ms powder coated louvers at bottom	Aluminium ventilator with louvers	600 X 600 and plane calcium silicate ceiling	
ii	TOILET 2	Anti-skid vitrified tile	300x300	NA	Vitrified wall tile up to false ceiling high. OBD above false ceiling	Vitrified wall tile up to false ceiling high. OBD above false ceiling	PVC DOOR and WPC main door with ms powder coated louvers at bottom	Aluminium ventilator with louvers	600 X 600 and plane calcium silicate ceiling	
iii	STAIRCASE -1	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating	Aluminium louvers	OBD	Anti skid groove in tread & SS railing

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
							2hr with panic bar			
iv	STAIRCASE -2	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
v	STAIRCASE -3	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
vi	Store Room	Kota stone	560x560	Kota Stone	Acrylic Emulsion Paint	Up to CEILLING	Hard core wooden flush door	Aluminium sliding window	OBD	
vii	Library	Vitrified tile	300x300	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	Floor mounted Glass door	Aluminium sliding window	Plane and 600 X 600 gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
ix	AHU	Kota stone	550x550	Kota Stone	White Wash	Up to CEILLING	Air tight MS Door with fire rating 2hr	Aluminium louvers	White wash	The room should be properly sound insulated using 19/13 mm thk elastomeric nitrile rubber insulation
x	electrical room	Kota stone	560x560	Kota Stone	OBD	Up to CEILLING	MS Door with fire rating 2hr	Aluminium louvers	OBD	
xi	lobby; Reception & waiting area	Granite	as per site	Granite	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted Glass door with adequate hardware	Aluminium sliding window	Plane gypsum ceiling	
xii	Corridors	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	-	-	Plane and 600X 600 gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
xiii	AV room	Carpet tile	As per compnay manufacture	Carpet	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	-	aqusticalfalse ceiling	
3	**SECOND FLOOR**									
i	TOILET 1	Anti-skid vitrified tile	300x300	NA	Vitrified wall tile up to false ceiling high. OBD above false ceiling	Vitrified wall tile up to false ceiling high. OBD above false ceiling	PVC DOOR and WPC main door with ms powder coated louvers at bottom	Aluminium ventilator with louvers	600 X 600 and plane calcium silicate ceiling	
ii	TOILET 2	Anti-skid vitrified tile	300x300	NA	Vitrified wall tile up to false ceiling high. OBD above false ceiling	Vitrified wall tile up to false ceiling high. OBD above false ceiling	PVC DOOR and WPC main door with ms powder coated louvers at bottom	Aluminium ventilator with louvers	600 X 600 and plane calcium silicate ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
iii	STAIRCASE -1	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
iv	STAIRCASE -2	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
v	STAIRCASE -3	Granite	as per site	Granite	Acrylic Emulsion Paint	-	MS Door with vision panel fire rating 2hr with panic bar	Aluminium louvers	OBD	Anti skid groove in tread & SS railing
vi	AHU	Kota stone	550x550	Kota Stone	White Wash	Up to CEILLING	Air tight MS Door with fire rating 2hr	Aluminium louvers	White Wash	The room should be properly sound insulated using 19/13 mm thk

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
										elastomeric nitrile rubber insulation
iv	electrical room	Kota stone	560x560	Kota Stone	OBD	Up to CEILLING	MS Door with fire rating 2hr	Aluminium louvers	OBD	
v	Display Area									
vi	Mantainence Room	Kota stone	560x560	Kota Stone	OBD	Up to CEILLING	Hard core wooden flush door	Aluminium sliding window	OBD	
vii	Store room	Kota stone	560x560	Kota Stone	White Wash	Up to CEILLING	Hard core wooden flush door	Aluminium sliding window	White Wash	
viii	Circulation + Lounge	Granite	as per site	Granite	Acrylic Emulsion Paint	Up to CEILLING	Frame less Floor mounted Glass door with adequate hardware	Aluminium sliding window	Plane gypsum ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING			CLADDING / WALL FINISH		DOOR/WINDOW			Remark
		TILE / SLAB	DIMENSION	SKIRTING	PAINT / SLAB	DIMENSION	DOOR	WINDOW	CEILING	
TRIBAL MUSEUM										
ix	Workshop	Kota stone	550x550	Kota Stone	OBD	Up to CEILLING	Hard core wooden flush door	Aluminium sliding window	OBD	

3. List of Approved Make

Following list of approved vendors are provided for different materials. However contractor may procure from other equivalent vendors after approval from employer.

SR. NO.	PRODUCT	BRAND, AGENCY
1.	AAC / flyash blocks	Charbuja, Aerocon, Siporex, Ecolite, CEEFpro, BLIT, First Build,Pasoblock
2.	GRC	Unistone, Birla White
3.	Concrete, Stone Sealar	Degussa, Wacker, Hytek, Aquamix, Laticrete, Kerakoll
4.	Fire Check Wood, Steel Doors	Signum, Godrej, Guardian, Navair, Shakti Hormann, Promat, Alhada,
5.	Flush Doors	Tata Conswood, Greenwood, Garnet, Merino, Century
6.	Door seals [dust / fire]	Lorient, Enviroseals, Pemko, Assorted
7.	Structural, Weather Sealant	Dow Corning, GE, Dupont
8.	Glazed, Ceramic & Vitrified Tiles	Euro, Naveen, Kajaria, Nitco, Jhonson, Somany
9.	Pigmented Joint fillers	Laticrete, Pidilite
10.	Cement Putty	Birla White, J K white
11.	Paint	Nerolac, Asian Paints, Dulux, Jenson & Nicholson, Berger, ICI, Oikos, Akzonobel, MRF
12.	Glass	Saint Gobain, AIS, Pilkington, Emirates
13.	Glazing Systems	Hydro, Domal, Kawneer
14.	Fire rated glass	Schott, Saint Gobain, ASI
15.	Doors, Window Fittings And Fixtures	Dorma, Giesse, Dline, Union, Yale, Assa Abloy brands

SR. NO.	PRODUCT	BRAND, AGENCY
16.	Toughening Agencies	Sejal, GSC, Gold Plus, Impact
17.	Lamination Films	Garware, Dupont
18.	Polycarbonate sheet	Lexan, Danpalon, GE, Tuflite, Plaram
19.	Gypsum & Mineral Fibre boards, systems, access panels & accessories	Saint Gobain, India Gypsum, Rondo, Armstromg, AMF, Knauf, Rehau, Lafarge, Gypsemma, USG
20.	False Floor	Unitile, Solidfeel
21.	Handrails	Technorails, Dline, Dorma, Carlf India,
22.	Polypyopylene Rungs	Pranali, Mase Safety Works, StepX
23.	Paver Blocks	As per OPWD Norms
24.	Thermoplastic Road Marking Paint	Asian Paint PPG-Apcomark, Automark Technologies (India) Pvt. Ltd.
25.	Fire Stop Mortar & Foam	Firestop, Hilti, Promat, Newkem
26.	Expansion Joints	CS expansion joints, BASF Eabco, Excel Tech
27.	Cast in Channels	Halfen Deha, Jordhal
28.	Sanitary wares	Hindware, Parryware, Cera, HR Jhonson
29.	Concealed flush tanks / valves	Gebrit, Jaquar, Schell, Commander, Viega, Parryware
30.	Faucets /sanitary fittings	Jaquar, Grohe, Schell,
31.	HDPE drain boards	Doerken, Green global, Pidilite
32.	CPVC plumbing pipes & adhesives	Flowgaurd, Astral ,Ashirwad, Prince
33.	Manhole covers	Neco, Municast,
34.	Light Fittings	Corvi, Bajaj, Philips, Trilux, Schreder,
35.	Gate automation & control	Gandhi automation, Boon Edam

SR. NO.	PRODUCT	BRAND, AGENCY
36.	AAC / flyash blocks	Charbuja, Aerocon, Siporex, Ecolite, CEEFpro, BLIT
37.	Waterproofing Treatment	Pidilite, BASF, FOSROC
38.	Anchor Fastener	Fischer, Hilti
39.	Entry Mat	Euronics, 3M
40.	High Pressure Laminate Panels	Fundermax, Wonder Alu Board, Viva Composite Panel, Greenlam
41.	Seating Gallery Bucket Chair	Iinnovative seating's pvt ltd, Krunal engineers, I Crystal Group, Baijnath Landscape
42.	WPC door	Vijayas, Ecoste WPC, Hardy Smith, Vinayak Enterprises, Anteak doors.
43.	Exposed Brick	Pioneer, Jindal
44.	Exterior textured plaster	Unistone and equivalant

TECHNICAL SPECIFICATION OF CIVIL WORKS

EARTHWORK

SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with earthworks of all underground supplies and services and for all structural units, stock piling, of specifications and applicable drawings, and subject to terms and conditions of the contract. The scope of this section of specifications is also covered with detailed specifications as laid down herein.

GENERAL

The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil which might be encountered during excavation of earthworks. The Employer does not guarantee or warrant in any way that the material to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the report, drawings or in any other contract documents or to material obtained from boring or trail holes. The contractor shall be deemed to have made local and independent inquiries and shall take the whole risk of the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive any extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.

All excavations, cutting, and fills shall be constructed to the lines, levels and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the period of maintenance the ground shall be at the required lines, levels and gradients.

During the course of the Contract and during the period of maintenance any damage or defects in cuttings and fills, structures and other works, caused by slips, falls or basins or any other ground movement due to the Contractor's negligence shall be made good by the Contractor at this own cost.

SITE PREPARATION

The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Project Engineer. The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.

The Contractor shall perform a joint survey with the Project Engineer's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork.

The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.

The Contractor shall perform a joint survey with the Project Engineer's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork.

EXCAVATIONS

Excavation shall include the removal of all material of every name and nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings and as directed by the Project Engineer.

The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as per drawings or as directed by the Project Engineer. The excavation which cannot be done by mechanical means including levelling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and back fill shall be stock piled within the free haulage limit of the 200m of the works.

The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Project Engineer full details of his proposals. The Project Engineer may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the Contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.

For major excavations, the Contractor shall submit for the prior approval of the Project Engineer full details and drawings showing the proposed method of supporting and strutting etc. The design, provisions construction, maintenance, and removal of such works shall be the responsibility of the Contractor and all cost in these respects shall be included in the unit rates for the permanent work.

The Contractor's attention is drawn particularly to his obligations under the general conditions in respect of those works which are in close proximity to existing buildings.

The Contractor shall preserve the complete excavation from damage from slips and earth movements, ingress of water from any source what so ever and deterioration by exposure to the sun and the effects of the weather.

All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the drawings in such a manner as to avoid interruption to work in other parts of the site. The Contractor shall be responsible for injury to the permanent works caused by excavation on other parts of the works.

Excavation shall extend to sufficient distance from walls and footing to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces.

All excavations in foundations shall be taken to 150mm and shall be trimmed carefully to a smooth and level surface, immediately after trimming to the final elevation a layer of building concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by concrete by the end of the day. It is specifically brought to the notice of the Contractor that any excavation taken down to the trimmed elevation which is left overnight or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the

Project Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.

No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the Project Engineer and his permission to proceed given. If excavation for sub-structures is carried below the required level, as shown in the drawings or as directed by the Project Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.

All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient equipment for this purpose. Adequate precautions shall be taken to prevent any corrosion due to undercutting from underneath the previously constructed adjoining foundations.

Existing utility lines to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be required to be repaired by the Contractor at his expense. Any existing utility lines which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Project Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Project Engineer in ample time for necessary measures to be taken to prevent interruption of the service.

Excavated material suitable for use as filling material shall be stock piled within the free haulage limit 200m of works as directed by the Project Engineer. This stock piled material shall be transported back to places requiring fill or backfill. Surplus or material unsuitable for use as filling shall be disposed of by the Contractor at locations approved by the Project Engineer within specified free haulage limit.

The Contractor shall make independent enquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer is not bound in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, drawings and documents.

Excavation for Recharge pits, Recharge trenches shall be taken out to the levels and dimensions as the Project Engineer may direct.

Before starting the excavations, the Contractor shall ensure the correct alignment of the recharge trenches and location of recharge pits on the ground, the depth and width of excavation of the trench and pits, all in accordance with the drawings and instructions of the Project Engineer.

The Contractor at his cost shall provide to the satisfaction of the Project Engineer all timbering, approved supports and shores and bracings to the sides of the excavated trench and foundations in such a manner to secure the sides of the trench and excavations from falling or adverse movement. All responsibility connected with such shoring shall rest with the Contractor. Adequate clearance / working space on both sides of the structure/pipe line shall be provided for which no payment shall be made.

Without the written permission of the Project Engineer no more than 50.0m the trench shall be opened in advance of the completed pipe line. The bottom of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottom of the pits and trenches shall be removed and the cavities so formed filled with lean concrete at the Contractor's expense.

The Project Engineer may require the Contractor to excavate below the elevations shown on the drawings or he may order him to step above the elevations shown depending upon the suitable foundation material encountered.

If for any reasons, the levels grades or profiles of the excavations are changed adversely, the Contractor shall at his own cost be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Project Engineer.

EXCAVATION TOLERANCES

Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the Project Engineer as accepted for the design and type of work involved.

BACK FILLING

The backfilling shall include filling around the foundations, trenches, earth filling in open areas for raising of ground level.

After completion of foundation footing, foundation, walls, and other construction below the elevation of the final grades and prior to backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris.

Filling shall be approved selected material from excavation or other predominantly granular material and free from slurry, mud, organic or other unsuitable matter and capable for compaction by ordinary means.

The excavated material if found suitable shall be stock piled within the free haulage limit of the site of the works. This material shall be used for backfilling if approved by the project engineer and shall be transported by the contractor anywhere required for the purpose of backfilling work in this contract.

The contractor shall provide the approved quality fill and backfilling material as required to complete the fill/backfilling work. Filling in trenches and foundation shall be placed in 200 mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the project engineer.

Fill in around trenches and pits shall be carefully placed with fine material to cover the completely before the normal infilling is done.

Material for back filling shall be as approved by the project engineer and shall be placed in layers of 150 mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum density at optimum moisture content, achieved in test no.15 of is 1377:1975 or similar clause of relevant is code.

All filled areas shall be left neat, smooth and well compacted with the top surface consisting of the normal site surface soil unless otherwise directed.

Depending on the depth of fill the project engineer may instruct increased thickness of successive layer to be placed.

Fill shall not be placed against foundation walls prior to approval by the project engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.

Depending on the depth of fill the project engineer may instruct increased thickness of successive layer to be placed.

Fill shall not be placed against foundation walls prior to approval by the project engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.

In case the contractor is instructed to arrange for the fill material the quality of the fill material will be subject to the approval of the project engineer. The project engineer shall require the contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the contractor. Once a material from a specific source has been approved, the material for the same quality and from that source only shall be used. Any fill material from borrow pits which has not been approved or the quality of which differs from the approved material shall be rejected out rightly. The project engineer reserves the right to order removal of any such materials brought to the site of works at his discretion at contractor's expense. In order to ensure satisfactory compaction, it will be necessary to carry out, depending upon the type of material, particle size distribution tests, determination of organic content tests, maximum and minimum density tests and determination of optimum moisture content for the filling material.

The method of compaction, namely type of compactor, type of roller, weight of roller and number of passes proposed by the contractor for any particular fill material shall be subject to the approval of the project engineer after completion of satisfactory field tests, subsequent to the laboratory analyses, using the materials and equipment proposed to be used for the earth work in conditions similar to those likely to be encountered during construction.

the final selection of the soil moisture content, the thickness of layers, the type of compaction equipment and the number of passes shall be decided after these tests, which shall be conducted at contractor's expense.

Having established the method of compaction to be used, no departure from this approved method shall be permitted without the prior approval of the project engineer. Adequate control of the fill and compacting operations shall be ensured by in-situ density tests and in order to obtain significant results, not less than two measurements shall be carried out per one hundred square meters of area compacted. The frequency of tests shall be determined on site and may be varied at the discretion of the project engineer. Compaction shall not be less than 95% in-situ density with respect to the maximum density, at optimum moisture content.

The exact thickness of layers and the method of placing and compacting the fill shall be determined by the field tests, as stated above, but not withstanding the results of these trails, fill shall not be placed in layers exceeding 200mm in thickness. In order to maintain control of the thickness of layers, timber profiles shall be used wherever feasible. The travellers of such profiles for each layer of fill shall be checked by the supervisory staff of the project engineer. The contractor shall provide adequate supply of water and sufficient capacity of mechanical water carriers to ensure uniform and uninterrupted operation of compaction. The project engineer may forbid the contractor to proceed with placing and/or compaction of fill and/or order removal and re-compaction of such fill when he finds that the contractor has insufficient or defective equipment or that the fill has been improperly laid and/or compacted.

If it is found necessary to alter the moisture content of the fill material in any way, then very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests.

The fill material should be well graded non-cohesive and nearly silt-free (silt content between 5 to 10 percent) salt free and free of organic materials (less than 2%). It should also be free of stones larger than 100 mm. Maximum dimension. It should be of such nature and characteristics that it can be compacted to the specified densities in reasonable length of time. It shall be free of plastic clays, of all materials subject to decay, decomposition or dissolution and or cinder or other material which corrode piping and other metals.

TOLERANCES

The stabilization of compacted backfill/fill surfaces shall be smooth and even and shall not vary more than 100mm in 3 meters from true profile and shall not be more than 12.5mm from true elevation.

DISPOSAL OF SURPLUS MATERIAL

The rejected unsuitable material and surplus excavated material shall be disposed of within 200 m free haulage limit measured from boundary of the works to places or as directed by the Project Engineer.

The disposal of surplus excavated material shall include loading, unloading, transporting, stacking, spreading as directed by the Project Engineer.

PLAIN AND REINFORCED CEMENT CONCRETE

The work covered by this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials, and in performing all operations in connection with the supply and installation of plain and reinforced concrete work, complete in strict accordance with this section of the Specifications and relevant documents, subject to the Conditions of the Contract.

GENERAL

Full co-operation shall be given to other trades to install embedded items and/or any associated services.

Embedded items shall have been inspected, and tests for concrete and other material or for mechanical operations shall have been completed and approved, before concrete is placed.

Formwork shop drawings shall be designed and prepared by the Contractor at his own cost. Approval of shop drawings as well as those of mock-ups /actual samples of finished concrete shall be obtained before Work is commenced.

Contractor shall prepare bar bending schedules, and get the same approved by the Project Engineer, prior to commencement of work.

RELATED SPECIFICATIONS

The codes and standards generally applicable to the work of this section are listed herein after.

IS 269 : Ordinary and low heat Portland Cement

IS 8041 : Rapid Hardening Portland Cement

IS 455 : Portland slag cement

IS 1489 : Portland Pozzolana Cement

IS 8112 : High Strength Ordinary Portland Cement

IS 12330 : Specification for sulphate resisting Portland Cement

IS 383 : Coarse and fine aggregates from natural sources for concrete

IS 456 : Code of practice for plain and reinforced concrete

IS 516 : Method of sampling and analysis of concrete

IS 1199 : Method of sampling and analysis of concrete

IS 1139 : Hot rolled deformed bars

IS 23896 : Methods of testing of aggregates for concrete (Part I to III)

IS 2751 : Recommended Practice for welding for reinforcement bars

IS 9103 : Admixtures for concrete

IS 10262 : Recommended guide lines for concrete mixed design

MATERIALS

CEMENT

Cement shall be used as mentioned in above clause in confirmation to relevant IS code and as directed by Engineer in charge depending on the nature of work.

Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.

There shall be sufficient cement at site to ensure that each section of Work is completed without interruption.

Cement reclaimed from cleaning of bags or from leaky containers shall not be used.

Contractor shall provide and erect, at his own cost, in a suitable place, dry, well ventilated, and water proof shed of sufficient capacity to store the cement.

The cement shall be used as soon as possible after delivery, and cement which the Project Engineer considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the site at Contractor's expense.

The mixing together of different types of cement shall not be permitted.

Recommended Brand : Dalmia, Ultratech, ACC and equivalent approved by employer.

AGGREGATES

The sources of supply of all fine and coarse aggregates shall be subject to the approval of Project Engineer.

All fine and coarse aggregates shall be clean and free from clay, loam, silt, and other deleterious matter. If required, Project Engineer reserves the right to have them washed by the Contractor at no additional expenses. Coarse and fine aggregates shall be delivered and stored separately at Site. Aggregates shall not be stored on muddy ground or where they are likely to become dirty or contaminated.

Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of IS: 383 latest editions.

Coarse aggregate shall be gravel or broken stone or hard, durable material free from laminated structure and conforming to IS: 383 latest editions. The aggregates shall be graded as follows for use in mass concrete as in foundations:

TOTAL PASSING	PERCENT BY WEIGHT
2" B.S. Sieve (50.00 mm)	100
1-1/2" Sieve (38.10 mm)	95-100
3/4" Sieve (19.00 mm)	35- 70
3/8" Sieve (9.50 mm)	10- 30
No. 4 Sieve (4.75 mm)	0- 5

Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits: -

TOTAL PASSING	PERCENT BY WEIGHT

1" Sieve (25.00 mm)	100
3/4" Sieve (19.00 mm)	90-100
3/8" Sieve (9.50 mm)	20- 55
No. 4 Sieve (4.75 mm)	0- 10

Water:

Only clean potable water from the city supply, tube well installed at the Site or from other sources approved by Project Engineer shall be used. Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where doubts exist as to the suitability of the water, it shall be tested in accordance with IS: 3025. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, Project Engineer may refuse to permit use. As a guide, the following concentrations represent the maximum permissible values:

To neutralize 200 ml sample, it should not require more than 2 ml of 0.1 normal NaOH.

To neutralize 200 ml sample, it should not require more than 10 ml of 0.1 normal HCL.

Percentage of solids should not exceed the following:

	PERCENT
Organic	0.02
Inorganic	0.30
Sulphates	0.05
Alkali Chlorides	0.10

In case of doubt, Project Engineer may require that concrete mixed with water proposed to be used should not have a compressive strength lower than 90 percent of the strength of concrete mixed with distilled water.

Reinforcement

Reinforcement for concrete shall conform to the respective IS or other standards as specified in the drawings and Contract Documents or as may be specified by Project Engineer.

Unless otherwise specified, all plain reinforcing bars shall comply with the requirements of IS: 432, and shall have a minimum yield stress of 248 N/sq mm.

Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of IS: 1786 for deformed cold worked steel bars and shall have minimum characteristic stress of 415 N/sq mm.

Reinforcement shall be obtained only from manufacturer's approved by Project Engineer. If and when required Contractor shall provide all necessary facilities to Project Engineer for the selection

of test pieces and shall cause these to be prepared and submitted where directed for tests at Contractor's cost.

If the reinforcement is to be supplied by Employer, Contractor shall inform Project Engineer of his requirements much before its use in construction.

Reinforcement of all types is to be stored at Site in an approved manner so as to avoid damage.

Contractor shall report immediately on receipt of any consignment, having any deviation in the standard weights of the reinforcing bars beyond those allowed in respective standards mentioned in clause (3.3.3.4.b) and (3.3.4.4.c) herein before.

CONCRETE MIX PROPORTIONS

General:

The proportions of ingredients shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the Work, but without permitting the materials to segregate or excessive free water to collect on the surface. Specific approval of the Project Engineer is required to waive limitations on mixture proportions.

The proportions of ingredients shall be selected to produce the proper placeability, durability, strength and other required properties.

Strength

The Specified compressive strength of the concrete cube shall be minimum 25 N/sq mm and required as per site. Samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.

Durability

Requirements of Clause 7 of IS: 456-1978 shall be followed.

Slump

Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 100 mm or less. A tolerance of up to 25 mm above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit.

Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

Note: If S.R. Cement is used, permissible water-cement ratio may be increased by 0.05.

Slump shall be determined by the "Test for slump for Portland Cement Concrete" as per relevant IS code.

Maximum Size of Coarse Aggregate:

The nominal maximum size of the aggregate shall be 20.mm for all portions of the structure except footings which may be 38 mm. These limitations may be waived if, in the judgment of the Project

Engineer, workability and methods of consolidation are such that the concrete can be placed without honeycomb or voids.

Admixtures:

If required or permitted, admixtures used shall be in accordance with the manufacturer's instructions except as otherwise specified herein.

Methods of Obtaining Mix Design:

For concrete of normal weight, mix proportions to provide the desired characteristics shall be developed using the methods/procedure covered by the Recommended Practice for Selecting Proportions for Normal Weight Concrete ACI-211.1-77/ IS:456- 1978.

Trial mixtures having proportions and consistencies suitable for the Work shall be made based on above codes, using at least three different water-cement ratios which will produce a range of strengths encompassing those required for the Work. Trial mixes shall be designed to produce the specified slump. The temperature of concrete used in trial batches shall be reported.

For each water-cement ratio, compression test of cube shall be made, cured, and tested in accordance with IS:1199 and IS:516. From the results of these tests a curve shall be plotted showing the relationship between the water-cement ratio and compressive strength. From this curve, the water-cement ratio to be used in the concrete shall be selected to produce the required design strength. The cement content and mixture proportions to be used shall be such that this water- cement ratio is not exceeded when slump is the maximum permitted. Control in the field shall be based upon maintenance of proper cement content and slump.

Ready mix concrete

GRADES AND STRENGTH REQUIREMENTS OF CONCRETE

General

Ready mix Concrete shall consist of the material described under site batched concrete sections, using separate coarse and fine aggregate in an appropriate combination determined in the course of the of mix design . The overall grading shall be such as to produce a concrete of the specified quality which will work readily in to position without segregation. The ready mix concrete shall conform to IS: 4926 and shall be delivered in agitating trucks. The RMC may contain flyash as per the acceptable norms.

Slump

The water shall be added to the cement and aggregate during mixing to produce concrete having a sufficient workability to enable it to be well consolidated, to be worked in to the corners of the shuttering and around the reinforcement to give the specified surface finish, and to have the specified strength. Water cement ratio shall be maintained as per IS456-1978 when a suitable amount of water has been determined, the resulting consistency shall be maintained throughout the corresponding parts of the work and tests shall be conducted to ensure the maintenance of this consistency. The max slump at the point of the discharge should not exceed 110mm max.

Concrete Grades

Grade of concrete used in the works shall be shown on the drawings or as directed by the Engineer-in-charge. The minimum cement used for M-20 shall be 300 Kg. Per Cum, 350 Kgs for M-25 and 400Kgs for M-30.

TRANSPORTING CONCRETE

Concrete shall be transported in agitating trucks without contamination, loss of ingredients or segregation. In no case shall a period of more than 4 hours have elapse between the wetting of mix and discharge of the concrete at site.

CONCRETE PLACEMENT

Concrete, when deposited, shall have a temperature of not less than 5oC (41oF) and not more than 32oC(90oF).

The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification and/or as directed by the Engineer-in-charge.

Contractor shall give adequate notice to the Engineer-in-charge of his intention to concrete any section of the works.

Except where otherwise directed, concrete shall not be placed unless the representative of the Engineer-in-charge is present and has previously examined and approved the positioning, fixing and condition of the reinforcement or any other items to be embedded and the cleanliness, positioning and suitability of the concreting surface.

The concrete shall be deposited as nearly as possible in its final position. It shall be placed in such a manner as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in horizontal layers not exceeding 450 mm in compacted thickness unless otherwise authorized or directed by Engineer-in-charge. Concrete shall not be placed simultaneously on each side of large horizontal specified or approved construction joints.

Shutters for walls or thin sections of considerable height shall be provided with openings or other devices that will facilitate the cleaning of the accumulation of hardened concrete on the shutters or on the metal reinforcement above the level of the concrete and the removal of concrete in the case of segregations.

QUALITY CONTROL

In order to ensure that the quality of materials and the mix proportions are suitable for the particular grade of concrete required are so maintained, sampling and testing shall be carried out regularly during the course or the works.

Workability testing shall be carried out in accordance with IS:456. The results shall lie within the range upon which the accepted mix design is based. Testing shall be carried out at such a frequency that the required workability is consistently achieved.

Samples of concrete shall be taken at random in accordance with IS: 516 at the time and place of deposition of the concrete at a frequency of sampling for each grade of concrete and from each concrete mixing plant at six cubes of 150 mm nominal size per 50 cubic meters of concrete placed in the works or twice per week.

Notwithstanding the foregoing, additional samples shall be taken by the contractor when directed by the Engineer-in-charge. The test cube procedure shall be in accordance with IS: 516 throughout.

Compliance with the specified characteristic strength shall be assumed if:

Each of the six cubes in a group has a test strength not less than the characteristic strength or,

Not more than one cube has a test strength less than the specified characteristic strength but not less than 85% of the specified characteristic strength and the average strength of the group of four test results is not less than the specified characteristic strength plus the standard deviation of the group.

SEVEN DAY CUBE TESTS

Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relationship between 7 days and 28 days strengths by carrying out 7 days tests at the time of performing the laboratory testing and from subsequent quality control testing. This relationship shall be used in interpreting any further test results to predict the probable value of the corresponding 28 days cube strengths. The contractor shall without delay advise the Engineer-in-charge of any sample that appears likely to fail to meet the specification and the contractor shall take any necessary action to minimize the effect of such failure.

ACCEPTANCE CRITERIA

The general Acceptance Criteria of any and all of the concrete work shall be as per the relevant Clauses of IS. 456. If any of the works tests are not up to the standard, the Engineer-in-charge shall have the power to stop the work until the reason is investigated and steps taken to prevent further low results. The contractor shall not be entitled to any claims on account of such delays. Any concrete carried out from the batch that is afterwards found to be faulty, will be liable for rejection and if so directed, the contractor shall at his own expenses dismantle and replace the defective work and any work built thereon or shall take such other measures as may be deemed necessary by the Engineer-in-charge. At the discretion of the Engineer-in-charge, the contractor may be allowed to prove by means of a load test to be carried out at his own expense, that the concrete is capable of safely withstanding the loads as specified in the test.

QUALITY OF WATER

Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

The pH value of water shall not be less than 6.

Seawater shall not be used for concrete mixing and curing.

The proposed admixtures shall comply with requirements of specification part 11- Water sealing materials.

STEEL REINFORCEMENT

SCOPE OF WORK

The work to be done under this section consists of furnishing, cutting, fabricating, bending, placing and tying steel reinforcement in concrete structures or elsewhere as shown on the drawings or directed by the Project Engineer. The scope of this section of this section of specifications as laid down herein.

MATERIAL AND SIZE OF BARS

Reinforcement for concrete shall conform to the respective Indian or other standards as specified in the drawings and in the contract documents or as may be specified by the Project Engineer.

Unless otherwise specified, all plain mild steel reinforcing bars shall comply with the requirements of IS: 432 (Part- I) and shall have a minimum yield stress of 250 N/mm.sq.

Unless otherwise specified, all deformed reinforcing bars shall comply with the reinforcements of IS: 1786 for deformed cold twisted steel bars and shall have a minimum characteristic strength of 415 N/mm.

Reinforcement shall be obtained only from manufacturers approved by the Engineer-in-charge. Each consignment of reinforcement steel shall be accompanied by a manufacturer's certificate or shall refer to a previous certificate, if the consignment is from the same batch, showing that the reinforcement steel complies with the following requirement

If such certificate is not made available or if the Engineer-in-charge considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.

Reinforcement of all types is to be stored on site in approved manner so as to avoid damage.

Reinforcement shall be free from all loose or flaky rust and mill scale or coating, including ice, and other substance that would reduce or destroy the bond. Reduced section steel reinforcement shall not be used.

If such certificate is not made available or if the Engineer-in-charge considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.

Reinforcement of all types is to be stored on site in approved manner so as to avoid damage.

Reinforcement shall be free from all loose or flaky rust and mill scale or coating, including ice, and other substance that would reduce or destroy the bond. Reduced section steel reinforcement shall not be used.

Steel wire mesh reinforcement shall conform to requirement of relevant Indian codes or those of ASTM: A 185-64 or BS. 4483, 1969: Standard Specifications for welded steel wire fabric for concrete reinforcement. It shall be used where shown on the drawings.

Applicable standards

Latest editions of Indian Standards or other International Standards

Recommended Make : TATA, Sail, Jindal and equivalent approved by employer

DELIVERY & STORAGE

Delivery

Steel reinforcement bars shall be delivered in bundles firmly secured and tagged. Each bars or bundle of bars shall be identified by marks stamped on hot or cold or painted on or by any other means. The identifying marks shall contain the following information:

Name of the producer or his trade.

Standard to which the bars have been manufactured.

The clause, type and strength respectively.

The diameter.

The number of the test certificate (if available).

Storage

The method of storage shall be approved by the Project Engineer. Reinforcing bars shall be stored in racks or platforms above the surface of ground and shall be protected free from scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separate.

BAR BENDING SCHEDULES

The Contractor shall prepare bar bending schedule of all the reinforcing steel bars and these bar bending schedules will be supplied to the Engineer-in-charge in duplicate on the basis of which the work shall be carried out. However, the Contractor shall be responsible to satisfy himself as to the correctness and accuracy of the bar bending schedule. Any discrepancy shall immediately be notified to the Engineer-in-charge before commencing work.

BRICK MASONRY

GENERAL

Brick Masonry shall consist of all work required in connection with constructing brick masonry at locations shown on drawings including, but not limited to, furnishing brick, Portland cement and sand for mortar and all other materials, and mixing, placing brick masonry as per bill of quantities.

MATERIALS

Cement for mortar shall be furnished by the Contractor and shall conform to the applicable requirements specified in the section "Plain and Reinforced Concrete". All sand for mortar shall be furnished by the Contractor and shall conform to the applicable requirements for sand specified in the section "Plain and Reinforced Concrete".

All water used in the manufacture of bricks and in the preparation of mortar shall be freefrom objectionable quantities of silt, organic matter, alkali, salts and other impurities,and will be tested and approved by the Project Engineer as per the guidelines of IS: 456.

MORTAR

MIX: Mortar for all brick masonry, expect where otherwise directed by the Project Engineer, shall consist of one-part cement to six parts of damp loose mortar sand by volume for brickwork 230mm and above. For brick piers, half brick walls, honeycombed brickwork and hollow (cavity) walls, the mortar mix shall consist of one-part cement and four parts of sand. Quantity of water shall be just sufficient enough to produce proper consistency for the intended use. Where directed and approved by the Project Engineer, hydrated lime putty, shall be added to the mortar for increased workability. The putty shall, however, not exceed 25% by volume of the dry cement.

Methods and equipment used for mixing mortar be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Project Engineer. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. The mixers shall be thoroughly cleaned and washed at the end of each day's work.

BRICK

All bricks shall be of first-class quality made from good brick earth, free from saline deposits and shall be sand moulded. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges parallel faces and of deep red or copper colour. First class bricks shall be homogeneous in texture and emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and nodules of lime. First class brick in an oven dried condition shall not absorb more than 1/5 of its weight of water when immersed for one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be 15N/mm. sq. and shall no result shall fall below 10 N/mm sq. The bricks in general shall conform to the requirements of IS: 1077.

All bricks shall be manufactured by the Trench Kiln method or other standard methods approved by the Project Engineer. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter salts shall not exceed 0.3% and calcium carbonate shall not exceed 2.0%.

The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. The size ready for use shall be 9" by 4 3/8" by 2 3/4" (229X 112X 70mm) and shall weigh between 3.2 to 4.2 Kilograms. All bricks shall have a "Frog" 1/4" deep on one face.

PLACING

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar which becomes diluted by rain shall be removed and replaced before continuing with the work. All bricks to be used in

brick masonry shall be moistened with water for three to four hours before they are used. The chosen method of wetting shall ensure that all bricks are thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

Bricks shall be laid "Frog" upward with mortar joints and in English bond as directed by the Project Engineer. Both bed and vertical joints shall be 6mm in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

The exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form weathered joints and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints.

CURING AND REPAIR

All brick masonry shall be water cured and shall be kept wet for least seven days by an approved method which will keep all surfaces continuously wet. Water used for curing shall meet the requirements of these specifications for water used in the manufacture of bricks.

If, after the completion of any brick masonry work, the brick are not in alignment or level or does not conform to the lines and grades shown on the drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Project Engineer grants permission, in writing to patch or replace the defective area.

TOLERANCES

The brickwork shall be erected plumb and true to line at level with the maximum variation in any storey height of any length of wall being one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be +/- 3mm.

FINISHING

GENERAL

All plaster work shall be of the best workmanship and in strict accordance with the dimensions of the drawings. All plastering shall be finished to true levels including plumbs, without imperfections, and square with adjoining work. It shall form proper foundations for finishing materials such as paint etc. Masonry and concrete surface to which plaster is to be applied shall be clean, free from efflorescence, sufficiently rough and keyed to ensure proper bond.

All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Engineer-in-charge.

All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Engineer-in-charge.

The materials used for plastering shall be proportioned by volume by means of gauge boxes. Alternatively, it may be required to proportion the materials by weight.

PLASTER WORK

The joints in the brick work, concrete blocks, shall be raked to a depth of 15 mm while the masonry is green. Concrete surfaces to receive plaster shall be suitably roughened. All walls shall be washed with water and kept damp for 10 hours before plastering.

The plaster unless specified otherwise shall be average of 12 mm thick on walls. The finished texture shall be as approved by the Engineer-in-charge. The mix for plaster unless otherwise specified, shall be one-part cement and four parts sand, to walls and one-part cement, 3 parts sand to ceiling.

The interior plaster shall be applied in one coat only. The surface shall be trowelled smooth to an approved surface. All plaster work shall be kept continuously wet for seven days

The external plaster shall be of two coats on an overall thickness of minimum 20 mm. Preparations of walls to receive plaster work shall be the same as in internal plaster. Backing coat shall be 12 to 15 mm thick with cement mortar 1:5 and finishing coat shall be with cement mortar 1:3.

Backing coats shall be combed on wet surface to form keys for finishing coat. All external plaster shall be waterproofed with approved water proofing powder added to cement in proportion of 1.5 Kg. to 50 Kg. of cement as per the manufacturers' instruction, for both the coats. Cost of waterproofing powder per Kg. shall be paid for separately.

For sand faced cement plaster, the finishing coat shall be in cement mortar 1:3, sand used shall be of selected colour, properly graded and washed so as to give a grained texture. Finishing plaster coat shall be 8 mm thick, uniformly applied and surface finished with special rubbing by sponge pads and other tools and recommended by the Engineer-in-charge.

TECHNICAL SPECIFICATIONS FOR STEEL WORK

FABRICATION OF STRUCTURAL STEEL

SCOPE OF WORK

This specification covers the general requirements for supply of all steel items where specified, fabrication, inspection, testing and delivery at site of all fabricated structural steel items. This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection of fabricated items.

The scope of work also includes but is not limited to proper stacking and storage of fabricated materials, transport from place of storage to place of erection, wherever required. All the works shall be carried as per approved QA procedures.

APPLICABLE CODES STANDARDS AND SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes and standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

IS 800	General Construction in Steel –Code of Practice
IS 803	Code Of Practice For Design, Fabrication And Erection Of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks.
IS 806	Code Of Practice For Use Of Steel Tubes In General Building Construction
IS 808	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections
IS 813	Scheme of symbols for welding
IS 814	Covered Electrodes for Manual Metal Arc Welding of Carbon And Carbon Manganese Steel-Specification
IS 816	Code of Practice for use of Metal Arc Welding for General Construction in Mild Steel
IS 822	Code of Procedure for Inspection of Welds
IS 1024	Code of practice for use of welding in bridges and structures Subjected to dynamic loading
IS 1161	Steel Tubes for structural purposes-Specification
IS 1182	Recommended Practice for Radiographic examination of Fusion Welded Butt Joints in Steel Plates.
IS 1239	Steel Tubes, Tubular and Other Wrought Steel Fittings-

IS 1239	Mild steel tubes, tubular and other wrought steel fittings-Part
IS 1363	Hexagon Head Bolts, Screws and Nuts of Product Grade 'C'
IS 1367	Technical Supply Conditions for Threaded Fasteners (All Parts)
IS 1395	Low and medium alloy steel covered electrodes for manual metal Arc welding
IS 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products(4th Rev)
IS 2062	Hot Rolled low, medium and High tensile structural steel
IS 2595	Code of Practice for Radiographic Testing
IS 3502	Steel Chequered Plates-Specification.
IS 3600:	Method of testing fusion welded joints and weld metal in steel (All parts)
IS 3658	Code of Practice for Liquid Penetrate Flaw Detection
IS 3757	Specification for High Strength Structural Bolts
IS 4000	Code of Practice High strength bolts in Steel Structures
IS 4260	Recommended practice for ultrasonic testing of butt welds in Ferritic steel.
IS 4353	Submerged arc welding of mild steel and low alloy steels – Recommendations
IS 5334	Magnetic Particle Flaw Detection of Welds-Code of Practice
IS 6639	Specification for Hexagon Bolts for Steel structures
IS 7215	Tolerances for Fabrication of Steel Structures.
IS 9595	Metal Arc Welding of Carbon and Carbon Manganese Steels-Recommendations
IS 12778	Hot rolled parallel flanged section for beams, columns
SP:6(1)	Structural Steel Sections.
AWS D1.1	Structural Welding Code: Steel

REGULATORY REQUIREMENTS:

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by OWNER.

STEEL MATERIALS

Steel materials shall comply with the specifications mentioned and/or as called for on the design drawings. All materials used shall be new, unused and free from defects.

STEEL SUPPLY – BY CONTRACTOR.

All steel and other material shall be procured and supplied by the CONTRACTOR, from the reputed manufacturers as mentioned in tender document. Steel proposed to be procured from other manufacturers shall have prior approval from the OWNER before placement of procurement order. However, OWNER reserves the right to accept or reject material from other manufacturers. Materials from re-rollers will not be accepted. Steel procured shall conform to the applicable codes & standards.

CONTRACTOR shall use materials for fabrication as specified in the approved drawings. All materials supplied by the CONTRACTOR shall be in sound condition, of recent manufacture, free from defects such as mill scales, slag intrusions, laminations, pitting, flaky, rust etc. and be of full weight and thickness as specified.

CONTRACTOR shall furnish the mill / manufacturer's test reports, along with the materials and satisfactorily demonstrates the specific grade and quality. Material test certificate shall be original.

All materials required for the work shall be correlated with manufactures test certificates. In the absence of test certificates, CONTRACTOR shall test materials through reputed laboratory approved by ENGINEER for establishing quality, at CONTRACTOR's cost and as directed by the ENGINEER.

Material supplied against this Test Certificates (TC) should have identification stamped on them. All such identification markings shall be authenticated by the inspection agency, which has inspected and approved the material.

The CONTRACTOR shall furnish to the ENGINEER duplicate copies of all purchase order copies covering the material ordered by him for the project under reference and also test reports.

The ENGINEER shall have the right to test random samples to prove authenticity of the test certificates produced by the CONTRACTOR at the CONTRACTOR's cost. Any material found not meeting the required specification would be rejected.

Whenever the CONTRACTOR desires to substitute structural members / shapes, plates for the sizes shown on the drawings, for want of availability of requisite materials, such substitutions shall be made only after authorization in writing by the ENGINEER. ENGINEER may also direct that substitution be made, when he considers such substitution to be necessary.

DRAWINGS

ENGINEER'S DRAWINGS (OWNER'S DRAWING)

Engineer will issue to CONTRACTOR such drawings and data as specified in Contract which may include, depending on Contract:

a) Preliminary Drawings and Data along with Tender / Enquiry.

CONTRACTOR'S DRAWINGS (Concrete Drawing)

Detailed engineering design drawings will be furnished by the CONTRACTOR and all drawings so furnished shall form a part of this specification. These design drawings prepared by the CONTRACTOR will show all the, levels, forces on members where necessary, size and orientation of each member, location/size of openings, to prepare drawings for construction. CONTRACTOR shall submit design calculations for each component present in the drawing/construction.

The Schedule of release of drawings shall be mutually agreed to, based on project schedules, unless such dates of drawing release are specified in Contract.

Engineer reserves the right to make changes, revisions to drawings, even after release for preparation of shop drawings, to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the OWNER shall be considered as part of this specification and contract without additional cost implication to the OWNER. The OWNER shall not entertain any extra claims on this account.

In case of variations in drawings and specifications, the decision of the ENGINEER shall be final.

Unless otherwise specified, the drawings and specifications are intended to include everything obviously requisite and necessary for proper and entire completion of the work and shall be carried out accordingly for completeness as required.

Each drawing prepared by the CONTRACTOR shall clearly indicate Names of OWNER, ENGINEER, CONTRACTOR, Project Title, Title of drawing, Scale, Notes, Details of revisions carried out etc; All titles, noting, markings and writings on the drawing shall be in English and all dimensions shall be in metric units. CONTRACTOR shall submit two (2) sets of hard copies of such "as built "drawings to OWNER for record purpose. The CONTRACTOR shall also furnish two sets of soft copies of all final approved Contractors' drawings in the form of CDs.

CONTRACTOR'S DRAWINGS (FABRICATION DRAWINGS)

Fabrication drawings shall be prepared by the CONTRACTOR or through an agency approved by ENGINEER at his own for "Released for Construction" and their subsequent revisions. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible. Drawings shall be prepared in computer tools and the details shall be drawn to the minimum scale as specified under.

a) Marking Plan: 1:75

b) Joint Details: 1:5; 1:10; 1:15

c) Elevations: 1:20

The CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER.

Key plan prepared by the CONTRACTOR shall indicate the fabrication / erection marking of each member and a table showing the corresponding fabrication drawing number where these members are detailed. Also, each drawing prepared by CONTRACTOR shall indicate corresponding design drawing number with revisions.

Each member shall be detailed separately unless members are identical in all respects with no deviation whatsoever. Shop detail drawings shall show all shearing, punching, drilling, bevel cutting, bending, and all welding in complete detail. All connections and splices shall be designed and detailed by the CONTRACTOR and clearly shown on the drawings. Bill of material shall show number, size, length, weight and assembly work of each erection piece. Bill of material for each drawing shall include fasteners/bolts, nuts, washers and other accessories complete with specification, size, length, numbers, etc for each erection mark and proper identification for each joint. Bill of material shall be prepared erection mark wise, showing weight of each component part and total weight of each erection mark. All revisions after initial issue of a drawing shall be clearly indicated with issue number and date of revision.

Each drawing prepared by the CONTRACTOR shall clearly indicate Names of OWNER, ENGINEER, CONTRACTOR, Project Title, Title of drawing, Scale, Notes, Details of revisions carried out etc; All titles, noting, markings and writings on the drawing shall be in English and all dimensions shall be in metric units. Before the commencement of preparation of fabrication drawings, CONTRACTOR shall discuss with the ENGINEER any specific requirement to be followed for fabrication drawing preparation.

No detailed shop drawings will be accepted by the ENGINEER unless they are complete and checked and approved by CONTRACTOR's qualified Structural ENGINEER and accompanied by an erection plan showing the location of all pieces detailed.

CONTRACTOR should check for erection clearance and ensure that detailing of connections is carefully planned to obtain ease in erection of structures including field-welded connection and bolting. Field connections/splices may be welded, or bolted type as specified in design drawings.

CONTRACTOR shall submit design calculations for each and every connection detail proposed by him and also for any substitution for members, desired by him and approved by the ENGINEER. Fabrication drawings not accompanied by calculation for connection details are liable for rejection.

Each lot of drawings sent by CONTRACTOR for approval shall contain a limited number of drawings and shall be in an order and manner which follows erection sequence or as required by ENGINEER based on priorities allocated. ENGINEER will return one copy of CONTRACTOR's drawing marked with ENGINEER's approval/comments. CONTRACTOR shall furnish the ENGINEER the required number of prints of all approved drawings for field use and record purpose.

In addition to standard engineering practice in detailing the following special requirements shall be strictly followed while detailing.

a) All butt welds shall be full penetration butt weld.

b) In the case of main columns fabricated out of plates, the weld connecting flanges and web to the base plate shall be double vee butt welds.

c) At column bases, wing plates shall be connected to the column flanges by full strength single Vee butt weld.

d) In the case of column, the thickness of the continuous fillet weld between flanges and web shall be a minimum of ½ the web thickness, unless a thicker size weld is specified in the design Drawings.

e) Shop splice location for flanges and web of columns shall be staggered by at least 500 mm such that only one full strength butt weld exists in one horizontal plane. Full strength butt weld for flanges shall be of single vee type and full-strength butt weld for web shall be of double vee type.

f) Where the thickness of plates changes, in the case of flange plates, outside surface shall be kept flush. The thicker plate shall be chamfered to slope of 1 horizontal to 5 vertical so that at the location of weld thickness of plate will be same on either side of weld. In the case of webs at the location where the plate thickness changes, the plates will be kept symmetrical to the vertical axis: the thicker plates shall be given a chamfer on both sides such that at the location of butt welds, thickness of plate on either side will be equal.

g) Similarly, where the width of the flange plate changes, the wider plate shall be tapered with a slope 1 horizontal to 5 vertical.

h) Site splicing may be by welding or by means of high tensile bolts. In the case of welded connection, efficiency of field butt weld shall be considered as 50% and cover plate shall be designed for 50% of the tensile strength of the plates spliced.

i) In the case of framing beams, the weld between flange and web shall be calculated based on standard formula considering the shear force as the full shear capacity of the web. Continuous weld shall be provided keeping size of weld uniform for the full length of girder. However, is no case the size of weld shall be less than half the web thickness.

j) Weld between flanges and web both for column as well as beams, shall be made using automatic welding machines, with proper sequence of welds to avoid warping.

k) Connection of bracings /tie beams to column shall follow the details given in the design drawings. Where such details are not given, the connection shall be designed for 50% of the tensile strength of the member unless design drawings indicate a higher load in the member.

The maximum size of the weld shall be less than or equal to the thickness of the rolled section at the location of connection.

l) Weld between flanges and web both for column as well as beams, shall be made using automatic welding machines, with proper sequence of welds to avoid warping.

m) Thickness of gusset plates shall be at least equal to the thickness of member connected and shall have adequate cross section to transfer the force at the point. If the members are connected on either side of gusset, thickness of gusset shall be more than sum of thickness of fillet weld on either side of gusset.

ENGINEER may review / approve the fabrication drawing at his option some, all or none of the fabrication drawings. Wherever such review is carried out the same shall be restricted to the following.

a) Review/ approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

b) Correctness of overall dimensions, centre to centre distance, elevations. Important / typical connection details (adequacy of number of bolts / weld length for few connections only will be checked), working points for bracing members and orientation and sizes / sections of members.

c) Sequence of erection in the light of project requirements.

d) Whether the fabrication drawings broadly conform to details shown on design drawings and comply with technical specifications, general notes, any specific notes made on design drawings and generally with the requirement of good engineering practice.

It shall be clearly noted by the CONTRACTOR that even where review is done by the ENGINEER, the following shall be the sole responsibility of the CONTRACTOR.

a) Provision for erection.

b) Marking of members.

c) Cutting Lengths of members

d) Matching of Joints and holes

e) Provision kept in the member for all other interconnected members

f) Bill of materials.

g) Gusset sizes.

h) Connections

Approval by ENGINEER of any of the fabrication drawings shall not relieve the CONTRACTOR from the responsibility for correctness of engineering, design of connections, workmanship, and fit of parts, details, material, errors or omissions of any and all work shown thereon. ENGINEER's approval shall not invalidate any claim for damages of any kind for incorrectly detailed / fabricated steel, notwithstanding any approval of such drawings by ENGINEER.

On completion of fabrication and erection, the CONTRACTOR shall update his fabrication drawings, incorporating all site changes and substitutions and shall submit two (2) sets of hard copies of such "as built "drawings to OWNER for record purpose. The CONTRACTOR shall also furnish two sets of soft copies of all final approved Contractors' drawings in the form of CDs.

Time consumed by the CONTRACTOR in securing approval of drawings should not be added to the time allowed for completion of contract. A period of two (2) weeks from the dates of receipt of drawings by the ENGINEER should be anticipated for this item of procedure in the schedule.

All these fabrication drawings submitted by the CONTRACTOR will remain the property of the OWNER. OWNER reserves the right to use them in any manner whatsoever.

FABRICATION

GENERAL

Fabrication shall not be started until CONTRACTOR has received copies of such drawings upon which ENGINEER has endorsed his approval. Any work done prior to approval of CONTRACTOR's fabrication drawings will be at the CONTRACTOR's risk. The CONTRACTOR shall make such changes in the design when so directed, which are considered necessary to make the structures conform to the provisions and intent of the specifications, without any additional cost to the OWNER.

All workmanship and finish shall be of the best quality and shall conform to good engineering practice and the best-approved method of fabrication. All materials shall be finished straight and shall be machined / ground smooth, true and square where so specified.

All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Standard fabrication clearances as detailed in the American Institute of Steel Construction Manual / BIS Codes shall generally be followed unless otherwise directed / approved.

Materials at the shop shall be kept clean and protected from weather. Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant Codes and Standards. In addition, the CONTRACTOR shall strictly adhere to the following.

a) All care should be taken to avoid undue welding distortions.

b) Complete layout shall be prepared and got approved by the ENGINEER before actual fabrications are started. If needed mock-ups may also be prepared.

c) All fit ups shall be got approved from the ENGINEER.

CONNECTIONS

All shop connections shall be welded unless otherwise specified in ENGINEER's design drawing. Field connections can be either welded or bolted and as shown in design drawings. Bolts used for erection shall conform to IS-6639 and as specified in the design drawings. Bolts used for permanent connections shall be high strength tensile bolts and shall conform to grade 'C' as per IS:1363 and property class 8.8 (minimum) as per IS:1367 or as indicated in design drawings.

All connections shall be designed for forces indicated on the design drawings or as specified elsewhere in the specification/standard drawing if not given in the design drawings. The CONTRACTOR shall be responsible for selection of standard connections from AISC Manual of Steel Construction or any other standards approved by ENGINEER.

All connections shall be designed and detailed as per guidelines given in IS800 code.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

Not more than one shop splice shall be provided to make up the full length of a member. Shop splices to make the full member lengths shall be of full penetration butt welded type and radio graphically tested.

Transportation or the CONTRACTOR's erection methods may require additional splices not shown on the drawings. The CONTRACTOR shall be responsible for the design and detailing of such splices or joints and shall submit these for the ENGINEER's approval.

All bolts, nuts, screws, washers, electrodes, etc. shall be supplied / brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity and no additional payment will be made for this extra quantity supplied.

All members likely to collect rain water shall have drain holes provided.

STRAIGHTENING

Rolled material, before being worked, shall be straightened, unless otherwise specified. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mandrel or levelling rolls and structural shapes by the use of mechanical or hydraulic bar/section straightening machines. Heating or forging shall not be resorted to without the prior approval of the ENGINEER in writing. In case of site fabrication, CONTRACTOR shall obtain ENGINEER's approval in writing on the straightening method proposed to be adopted before commencing the work.

Checking of the straightness of the structural members like angles, channels, beams etc. shall be done by using the thread. For checking of the straightness of the column sections piano wire shall be used. The sections, which are twisted beyond repairs, shall not be used for fabrication. Heating or hammering shall not be permitted. After removal of bends structural members shall be submitted for inspection and approval of ENGINEER.

CUTTING

Cutting may be done by shearing, cropping, sawing or machine flame cutting. All re-entrant corners shall be shaped notch free to a radius of at least 12-mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

Hand flame cutting shall be undertaken, only if so permitted by the ENGINEER and shall only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight.

Edges of flange cover plates and plates used to form any sections shall be ground smooth.

PUNCHING AND DRILLING

Holes in secondary members such as Purlins, grits, lacing bars etc. may be punched full size through material not over 12 mm thick. Holes should be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances such parts shall be first assembled, tightly clamped together and drilled through.

Sub-punching may be permitted before assembly, provided the holes are punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not in such cases exceed 16 mm.

When match drilling is carried out in one operation through two or more separate parts, these parts shall be separated after drilling and the burrs removed.

Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919.

Where reamed members are taken apart for transporting or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over drilling and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

Holes may be required to be drilled by the CONTRACTOR at no extra cost at site for installing equipment or steel furnished by other agencies. The information for this will be supplied to the CONTRACTOR by the ENGINEER before or after erection of the steel. Holes should be by drilling or other machining process and not by gas cutting sets.

ROLLING AND FORMING

Plates, Channels, Rolled Steel joists etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

GRINDING:

Column ends bearing on each other, resting on base plates, compression joints designed for bearing, base plates coming in contact with column end and cap plate shall be ground smooth to ensure 90% contact with local gap not exceeding 0.10 mm (filler gauge shall be used to check this gap). Bottom edge of knife edge support (bearing stiffener) for crane girder and top of cap plates where the knife edge supports rest shall also be accurately ground as adobe. All ground surfaces shall be protected from dirt and mechanical damages till the assembly is completed. However the underside of base plate bearing on grout need not be machined.

WELDING

Before the start of the work, welding procedure shall be submitted to ENGINEER for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per relevant standards.

Welding procedure specification (WPS) shall be established and Qualification of weld procedure (QWP) shall be done as per approved standards. Welders employed shall also be qualified as per above standards prior to taking up fabrication. CONTRACTOR shall obtain approval from ENGINEER before the start of the work.

Following pre-qualified welding process shall be employed for fabrication, erection and repair and the same shall have the approval of ENGINEER before adopting the welding process on the job.

a) Submerged Arc Welding (SAW).

b) Shield Metal Arc Welding (SMAW).

c) Gas Metal Arc Welding (GMAW).

d) Gas Tungsten Arc Welding (GTAW)

All welds shall be free from defects like blowholes, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

50mm on either side of the surfaces on which weld metal is to be deposited shall be smooth, uniform, free from fins, tears, burrs,cracks and absolutely free from grease, paint, loose scale, moisture or any other substance which would adversely affect quality and strength of weld.

Machining, thermal cutting or grinding may be employed for joint preparation or removal of unacceptable work or metal. The weld edges shall be smooth & regular surface, free from cracks & notches. Flame cut material above 50mm thick shall be pre-heated as per relevant standards prior to flame cutting and shall be subjected to ENGINEER's approval.

All weld fit-up shall comply with tolerances specified in the relevant standards. The parts to be joined by fillet welds shall be brought into close contact as practicable and within the tolerable limits as per relevant codes & standards. All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirement specified in the welding procedure shall also apply to tack welds. All tack welds shall be examined visually for defects and if found defective, shall be removed and re-welded. Throat thickness, leg length and length of tack weld shall be as per IS: 9595.

Welding of temporary attachment/fixtures to retain fit up is permitted in case the parts have a nominal thickness of at least 10 mm. Temporary attachments are welded at the minimum distance of at least 50 mm from the weld seam. Welding of temporary attachments/fixtures into the joint slot is not allowed. All temporary fixtures shall be removed after welding, by grinding them to weaken the welded portion and hammering thereafter followed by grinding the portion of any weld remaining on the base metal. A dye check at the discretion of the quality surveyor shall be done to detect any crack/defect at the point of fixture temporary weld.

It is not allowed to turn over and carry over heavy assemblies in tacking condition in order to control the geometric dimensions to the requirements of the drawings. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided as far as possible.

In the joints of the parts with dissimilar thickness smooth transition of one part to the other must be provided by way of the gradual decreasing of the thickness of the thicker part with the slope of the surface not exceeding 15 degree.

Welding shall not be done when the surface of the members are wet or exposed to rain or high wind velocities unless the welding operator and the work are properly protected.

In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as per IS 9595-1996.

Welds shall be defect free and surfaces shall be thoroughly cleaned to remove all visible weld defects and extra material.

For all built up sections such as Columns, Crane Girders etc welding between web and flange plates shall be carried out by SAW process. Especially for butt welds of Crane girders full penetration of weld between top of web plate and top flange shall be ensured. Welding shall be continuous and shall be on both sides of the connecting member. One side fillet weld is not acceptable.

In general, all welding shall be performed as per the recommendation specified in IS: 9595-1996.

Pre-heating and Post weld Heat treatment shall be carried out as per the acceptable standards and procedure and shall have prior approval from the ENGINEER. The pre-heat and inter pass temperature shall be checked just prior to initiating the arc for each pass. The weld joint details and procedure for Pre-heating and Post heating shall be submitted by the CONTRACTOR for approval from ENGINEER.

WELDING CONSUMABLES.

Electrodes, filler wires and flux used for welding shall be from approved manufacturers/Suppliers. CONTRACTOR shall submit the list of Electrode manufacturers proposed to be procured to the ENGINEER for approval. The CONTRACTOR shall furnish certification that electrode or electrode flux combination will meet the requirements of classification. The classification and size of electrode, arc length, voltage & amperage shall be suited to type and thickness of material, type of groove, welding positions and other circumstances attending work.

Only low hydrogen electrodes shall be used for welding. All electrodes having low hydrogen covering shall conform to relevant acceptable standards. These electrodes shall be purchased in hermetically sealed containers or baked by the user as recommended by electrode manufacturer. Electrode flux coating shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Before welding, the electrodes shall de dried in a holding oven at 120OC at least for one (1) hour or as per manufacturer's recommendations. Only limited quantity shall be issued to the welders. The electrodes shall be kept in "carry ovens" and shall not be exposed to the atmosphere.

Welding plants and accessories shall have capacity adequate for welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality. CONTRACTOR shall furnish and obtain approval from ENGINEER the details of equipment he proposes to deploy for the works. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided. Proper safety rules shall be strictly followed.

TESTING, INSPECTION AND REPORTS

GENERAL

On award of work, the CONTRACTOR shall submit to ENGINEER, his Field Quality Plan (FQP), outlining the types, details and extent of inspection he proposes to execute, covered in the rates quoted for various items of work.

CONTRACTOR shall give due notice to ENGINEER in advance of the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for ENGINEER's approval / inspection. The fact that certain material has been accepted at CONTRACTOR's shop shall not invalidate final rejection at site by ENGINEER if it fails to conform to the requirements of these specifications, be in proper Condition.

No material shall be painted or dispatched to site without the inspection and approval by ENGINEER unless such inspection is waived in writing by the ENGINEER.

Shop inspection by ENGINEER or submission of test certificates and acceptance thereof by ENGINEER shall not relieve CONTRACTOR from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which the ENGINEER may make because of defective or unsatisfactory material or workmanship.

CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. CONTRACTOR's inspection work shall be under the control of competent Chief Inspector whose primary responsibility is inspection (reporting to Management) and not to production department.

For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to ENGINEER. The inspection and testing on structural steel members shall be as set forth below:

MATERIAL TESTING.

All materials conforming to a particular Indian or any other standard as called for shall be tested as required by such standard. Proof in the form of certified test reports or mill certificates indicating that the required tests have been carried out as per specification at the source is acceptable.

If mill test reports are not available for any steel materials, the same shall be got tested by CONTRACTOR to ENGINEER's satisfaction to demonstrate conformity with the relevant specification at his own cost.

Raw material with cracks, seams, laps, lamination and heavy pitting are not acceptable. Ultrasonic testing of plates above 50 mm thick shall be carried out for the soundness of material.

Engineer has option to specify additional inspection or testing as he deems necessary and the additional cost of such testing shall be borne by the CONTRACTOR.

The CONTRACTOR shall maintain records of all inspection and tests, which shall be made freely available to the ENGINEER and shall be submitted to the ENGINEER on completion of each stage of work.

TESTS ON WELDS

All welds shall be tested for flaws by any of the methods described under. The choice of the method adopted shall be determined by the OWNER. Following methods are generally recommended for the quality control of welded joints:

Magnetic Particle Test(MPT): All fillet welds in general structural steel work shall have their final passes fully tested by MPT. However, for fillet welds of size 10mm and above and /or critical

areas, the root and final passes shall be tested using MPT. The ENGINEER shall however decide the requirements of this additional testing. For Complete penetration butt welds, the root and final passes shall be tested using MPT. All MPT shall be as per relevant acceptable standards. Defects if found, shall be repaired and retested. MPT shall be carried out using alternating current only. Direct current may be used with the permission of the ENGINEER. The cost of demagnetizing after testing is deemed to be included in the quoted rates of the CONTRACTOR.

Dye Penetrant Test (DPT): MPT may be substituted by Dye Penetrant Inspection where the former is not feasible due to configuration. The testing should be in accordance with relevant acceptable standards.

Radio-graphic Inspection (RT): All completed full penetration butt welds to a length of about 10% shall be radio-graphed as per ENGINEER's directive in accordance with the relevant acceptable standards. In case of crane girders 100 percent of the splicing shall be inspected by RT. In the case of hoppers of coal bunkers at least 10% of the circumferential as well as seam welds shall be inspected by RT.

Ultrasonic Testing (UT): Wherever built up sections for crane runway girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic testing. 100 percent length of the seam as well as circumferential welds of hoppers of coal bunkers shall be inspected by UT.

Acceptance Standard: The acceptable standards for various weld tests shall be as per ASME Sec VIII- Div I or relevant acceptable standards.

INSPECTION OF WELDS

Welding shall be carried out as per approved WPS and QWS by qualified welders.

All welds shall be inspected for flaws by any of the methods described,the choice of the method adopted shall be determined by the ENGINEER.

The correction of defective welds shall be carried out as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER shall be used to ensure that the whole of the crack and material up to 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the CONTRACTOR's account.

CONTRACTOR shall perform the following minimum tests on welds if not covered in any clause mentioned, with no cost implication to the OWNER. CONTRACTOR's quoted rate is deemed to have included the cost of such tests.

SL NO	Location & Type of weld	Type of Test	Extent of test	Remarks
1	All fillet welds in general other than those covered under the Sl no 2 ,3,5,7 & 8	DPT	1% of fillet weld with minimum of one test on	

SL NO	Location & Type of weld	Type of Test	Extent of test	Remarks
			each member / joint	
2	Fillet welds for plate thickness greater than 25 mm and fillet size more than 10 mm	MPT / DPT	10%	
3	Flame cut edges of plates more than 38 mm for fillet weld.	MPT / DPT	100%	
4	Flame cut edges of plates greater than 25 mm for butt welds,	MPT / DPT	100%	
5	Fillet welds between tension flanges and webs	MPT / DPT	100%	
6	Full penetration butt welds	DPT	100 %	DPT shall be carried out after back gouging
7	Fillet Weld greater than 12 mm on flame cut edges of low alloy steel	MPT	100%	
8	Fillet Welds for built up girders, columns and other heavy structures for penetration.	Mac ro etch test	One (1) test Per structure for penetration	

SL NO	Location & Type of weld	Type of Test	Extent of test	Remarks
9	Butt welds of thickness greater than 25 mm and less than 32 mm	MPT / DPT	100%	
10	Butt welds of thickness greater than 32 mm	RT	100%	
11	Butt welds of rolled sections having depth greater than 600 mm	RT	100%	

In addition to the minimum tests to be conducted by the CONTRACTOR, ENGINEER reserves his right to direct the CONTRACTOR to conduct additional tests. The extent, type and location of test shall be decided by the ENGINEER. These additional tests shall be conducted by the CONTRACTOR or through an approved agency in presence of the ENGINEER. If the test fails, the cost of that test shall not be payable to the CONTRACTOR. The tests which when successful will be paid for at the rates specified in the schedule.

WELD DEFECTS AND ACCEPTABLE CRITERIA

Type of defect	Acceptance Criteria	Remarks
Cracks	Not acceptable	
Incomplete or lack of Fusion	Not acceptable	
Mis-alignment of butt welds	0.25 x T (maximum of 3 mm)	T: Thickness of thinner plate
Reinforcement	Max reinforcement of 2 mm for t < 10 mm 3 mm for t > 10mm < 15 mm. 4 mm for 15 mm and greater	
Undercut	0.25 mm deep max	

Sharp edges	Min radius of 2 mm	

WELD REPAIRS

Whenever weld repair is required, CONTRACTOR shall give prior intimation to the ENGINEER and obtain permission before the repair is taken up. When a defect is detected in a weld, it shall be removed by cutting / grinding and smooth blending of the area with parent metal without sharp edges, corners. If welding is required, the same shall be done using the qualified procedure / welder and stage inspection as per the original weld. Correction of defect in

the same portion of the weld shall not be allowed more than two (2) times. Portion of the welding seams, which have been subjected to repair, must be indicated in the weld inspection reports.

INSPECTION AND TESTS ON STRUCTURAL STEEL FABRICATED MEMBERS

Inspection and tests on Structural Steel Fabricated Members shall be as set forth below:

All the fabricated parts of Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish are in accordance with the requirements shown on the approved CONTRACTOR's shop drawings and/or ENGINEER's drawings.

Fit ups shall be examined by the quality surveyor as per the approved QA plan prior to welding the joint. All welds shall be inspected for flaws by the method described under the Clause 7.4 (Inspection Of welds).

The dimensions of the fit ups shall be maintained as specified in the fabrication drawings.

Dimensions of all the assemblies and sub-assemblies shall be as per fabrication drawings within the tolerances specified in IS 7215

TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS:1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS:7215.

TEST FAILURE

In the event of any failure of welding, structural steel members to meet inspection or test requirements, the CONTRACTOR shall notify the ENGINEER or his authorised representative. A design concession request has to be made and got approved from the ENGINEER or his representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by ENGINEER.

CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorised representative, for three years from the date of completion of the contract.

The ENGINEER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the OWNER only in case of successful testing.

SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by CONTRACTOR at no extra cost to the OWNER.

DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other CONTRACTORs shall be drilled by the CONTRACTOR at no extra cost to the OWNER. The information for such extra holes will be supplied by the ENGINEER.

MARKING OF MEMBERS

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. In case ENGINEER rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the

ENGINEER’s requirements by CONTRACTOR free of cost at site.

QUALITY SURVEILLANCE

GENERAL.

The ENGINEER shall subject all works and materials covered by this specification to Inspection.

The CONTRACTOR shall provide free access in his shop during working hours for the inspection staff, designated by the Engineer, at all phases of the work and assist them where necessary in conducting the inspection. The CONTRACTOR shall expeditiously furnish all gauges, instruments and other necessary measuring equipment required for inspection of the work in the shop. The shop inspection by the inspector is intended to ensure that the material and workmanship are in accordance with this specification, but it will not relieve the CONTRACTOR of any of his responsibilities for the product. The inspector’s inspection will include, but not be limited to, the following:

MATERIAL

The inspector will ascertain that only materials conforming to the requirements of this specification are used.

DIMENSION AND TOLERANCES

The ENGINEER will ensure and check that the structural members conform to the dimensions and tolerances as set out on the drawings and as required by the specification.

WELDING PROCEDURE

ENGINEER will witness the welding and testing of any procedure qualification tests that are by this specification. The ENGINEER will also check that welding procedure (including the electrode, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

WELDING EQUIPMENT

The ENGINEER will check the welding equipment to be used for the work to ensure that it is such condition as to enable qualified welders to follow the procedures.

WELDER AND WELDING OPERATOR QUALIFICATIONS

The ENGINEER will permit welding to be performed only by welders and welding operators who are qualified by tests in accordance with relevant standards

When the quality of a welder or welding operators' work, appears to be below the requirements, the ENGINEER may require testing of his qualifications by necessary tests.

WELDS

The ENGINEER will ascertain that the sizes, length and the location of all welds conform to the requirements of this specification and the approved fabrication drawings. Temporary welds used for the works shall be removed and ground flush with the original surface.

The ENGINEER will identify with a distinguishing mark of all parts of the joints that he has inspected and accepted.

The CONTRACTOR shall comply with all the demands of the ENGINEER to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient.

In the event of faulty welding or its removal for rewelding results in damage to the base metal in the judgment of the Engineer, or its retention is not in accordance with the intent of the plans and specification, the CONTRACTOR shall remove and replace the damaged materials at his own cost.

ERECTION OF STRUCTURAL STEEL

SCOPE

This specification covers the general requirements for erection of structural steel. In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labor and supervision and shall cover the following:

Storing and staking of all fabricated structural components/units/assemblies at site storage yards till the time of erection.

Transportation of structures from storage yard to site of erection, including multiple handling, if required.

All minor rectifications/ modifications such as: -

i. Removal of bends, kinks, twists etc for parts damaged during transportation and handling

ii. Reaming of holes which do not fit properly, or which are damaged, for use of next higher size bolt.

iii. Plug-welding and re-drilling of holes which do not register, and which cannot be reamed for use of next higher size bolt.

iv. Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.

Fabrication of minor missing items as directed by the OWNER.

Verification of the position of embedded anchor bolts and inserts w.r.t lines and levels, installed by others based on Geodetic Scheme /Bench Mark/Reference co-ordinates to be furnished by OWNER.

Verification of actual dimensions of structures (erected by others) which would have bearing on the cutting lengths, end connections etc of those members which are to be erected under this scope of work.

Assembly at site of steel structural components wherever required, including temporary supports and staging

Making arrangements for providing all facilities for

i. Conducting Ultrasonic Testing (UT) by reputed testing laboratories approved by OWNER.

ii. Making available test films / graphs, with reports / interpretation.

Rectifying at site damaged portions of shop primer by cleaning and application touch-up paint.

Erection of structures including making connections by bolts/ High strength Friction Grip bolts / welding as per drawing.

Alignment of all structures true to line, plumb and dimensions within specified limits of tolerance.

Application at site after erection, required number of coats of primer and finishing paint as per specification.

Rectification of structures as per preliminary acceptance report and Final acceptance report.

All necessary items of work required for satisfactory completion of job on schedule.

APPLICABLE CODES STANDARDS & SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern. It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

Reference codes and standards:

IS 800	General Constructions in Steel –Code of Practice.
IS 806	Code Of Practice For Use Of Steel Tubes In General Building Construction.
IS 822	Code of Procedure for Inspection of Welds.

IS:1363 Hexagonal Head Bolts, screw nad nut of Product grade C IS:1367 Technical Supply Conditions for threaded fastener (all parts)

IS 4000	Code of Practice High strength bolts in Steel Structures.
IS 7205	Safety code for erection of structural steel
IS 7969	Safety code for handling and storage of building Materials
IS:9595	Metal Arc Welding of Carbon and Carbon manganese steel.
IS 12843	Tolerances for erection of steel structures.
SP:6(1)	Structural Steel Sections.
AWS D1.1	Structural Welding Code: Steel

REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by OWNER.

ERECTION SCHEME

CONTRACTOR after the award of work shall submit a detailed erection scheme covering the period of completion of all the works covered under the specification for ENGINEER's approval. The erection scheme shall include but not limited to the following.

i. Methods proposed to be employed for transporting his equipments, tools, tackles, gas cylinders, electrodes and all that is necessary to site.

ii. Type, capacity and quantity of equipment that the CONTRACTOR proposes to bring to site for unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components for all these operations.

iii. Strength and trade wise composition of the work force and supervisory personnel that will be deployed by the CONTRACTOR for the various operations.

iv. Any special specific scheme being adopted for erection of special / complicated structural elements such as roof trusses etc.

A brief write-up covering the above activities shall be submitted along with the bid document by the Bidder during submission of his bid.

ENGINEER reserves the right to direct the CONTRACTOR either at the start or during the contract period , to mobilize additional resources in terms of labour, material ,equipment, tools and plant etc at no cost to the OWNER if in his opinion that the resources employed by the CONTRACTOR does not meet the schedule of completion.

ERECTION PROGRAMME

Within two (2) weeks of acceptance of bid the CONTRACTOR shall submit a detailed erection programme with dates and estimated completion time for various parts of the work for ENGINEER's approval. This programme shall broadly comprise the following:

i. Layout plan identifying the areas proposed for unloading, main storage,

Subsidiary storage and assembly

ii. Transportation of fabricated material between the storage and work areas.

iii. Layout to indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc.

iv. The locations and extent of site offices and stores, labor quarters if any. v. Layout of electrical cables and water pipes from the tap-off points.

vi. Details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying, etc. along with complete details of the quantity and capacity of the various items of erection equipment that will be used.

vii. Site organization chart showing the number of supervisory personnel, and the number and composition of the various gangs.

viii. Safety measures to be adopted at site of erection and organization chart showing safety personnel.

Any modifications to the erection programme directed by ENGINEER for the reasons of inadequacy of

i. The quantity and/or capacity of the erection equipment.

ii. Erection personnel and supervisors, temporary bracing, guying etc.,

iii. Safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies.

iv. Any other unforeseen events which may delay the schedule.

v. Safety measures proposed.

Shall be incorporated by CONTRACTOR and the work shall be carried out in accordance with the revised programme. Approval by ENGINEER shall not relieve the CONTRACTOR from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by ENGINEER/OWNER. CONTRACTOR shall also make no extra claims for bringing additional equipment to site for erection, if so directed by ENGINEER.

CONTRACTOR shall be deemed to have visualized all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

SITE OPERATIONS

CONTRACTOR shall employ an experienced and qualified graduate Engineer who shall be in full time charge of the job and responsible for all site activities.

CONTRACTOR shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and preassembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

CONTRACTOR shall furnish at his own expense, the necessary non inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job.

CONTRACTOR shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of OWNER / ENGINEER and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain CONTRACTOR's electrical equipment and connections.

CONTRACTOR shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by CONTRACTOR shall be rectified entirely at CONTRACTOR's cost, to the satisfaction of OWNER / ENGINEER. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, CONTRACTOR must ensure suitable safety precautions in consultation with ENGINEER.

If a portion of the work of the project area cannot be made available to CONTRACTOR for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. CONTRACTOR shall work in

coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

The Suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the OWNER/ENGINEER.

ACCEPTANCE, HANDLING AND STORAGE

The fabricated material received at erection site shall be verified with respect of marking on the key plan / marking plan or shipping list.

Any material found damaged or defective shall be stacked separately and the damaged or defective material shall be painted in distinct colour for identification and the same shall be brought to the notice of ENGINEER.

No dragging of steel shall be permitted. All fabricated items shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by CONTRACTOR. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by CONTRACTOR well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with TCE specification M4-405-04 (painting of structural steel) after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

ANCHOR BOLTS, EMBEDDED PARTS AND FOUNDATIONS

CONTRACTOR shall carefully check the location, level and layout of anchor bolts embedded in foundations constructed by others, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to ENGINEER.

CONTRACTOR shall carefully check the actual dimensions of structures and also the location, level and sizes of embedded parts a) in the RC beam /column and/ or b) cleats / plates provided in steel beam /column constructed by others to receive structures covered under this scope of work. CONTRACTOR shall take note of discrepancies if any, shall be reported to ENGINEER and fabricate the structures covered under this contract suitably before the commencement of erection.

Levelling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by CONTRACTOR at his cost.

A certain amount of chipping/cleaning of foundations and preparing the area is considered normal and shall be carried out by CONTRACTOR at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by CONTRACTOR, unless the grouting is specifically excluded from the CONTRACTOR's scope.

ASSEMBLY AND CONNECTIONS

Field connections may be effected either by bolting, welding or by use of high strength friction grip bolts as shown in the design and erection drawings.

All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by CONTRACTOR free of cost. The materials shall have prior approval from the OWNER /ENGINEER and necessary test certificates shall be furnished to ENGINEER's approval. Materials shall be procured from the reputed manufacturers with prior approval from OWNER /ENGINEER

All assembling shall be carried out on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of ENGINEER.

Corrections of minor misfits and reasonable amount of reaming shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to ENGINEER.

ERECTION

Erection work shall be taken up after receipt of clearance from the ENGINEER.

All structural steel shall be erected as per approved Design / fabrication drawings.

For safety requirements during erection, provisions of IS: 7205,IS:7969, IS800 and other relevant codes shall be strictly followed.

Erection shall be carried out with the help of maximum mechanization possible.

Prior to commencement of erection, all the erection equipment, tools, tackles, ropes etc shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary. Frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipments, if any.

Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment etc. Erected parts of the structure shall remain stable during all stages of erection when subjected to action of wind, dead weight and erection forces etc. Such bracings shall be left in place as long as may be required for safety and stability. Specified sequence of erection of vertical and horizontal structural members shall be followed

Erected members shall be held securely in place by bolts to take care of dead load, wind / seismic load and erection load.

All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

All connections shall achieve free expansion and contraction of structures wherever provided.

No final bolting or welding of joints shall be done until the structure has been properly aligned and approved by ENGINEER.

For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required using precision survey instruments. The final levelling and alignment shall be carried out immediately after completion of each section of a building.

The CONTRACTOR shall design, manufacture, erect and provide false work, staging temporary support etc,. Required for safe and accurate erection of structural steelwork and fully responsible for the adequacy of the same.

The CONTRACTOR shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments etc. to OWNER for his inspection at any stage during erection.

Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by ENGINEER in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls steel or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. Trusses which are very slender in the lateral direction shall be provided with temporary lateral supports till the horizontal bracings are erected. All steel columns and beams shall be checked for plumb and level individually before and after connections are made.

Chequered plates shall be fixed to supporting members by welding or by countersunk bolts as shown/specified in relevant drawings and/or as directed by ENGINEER. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include :

a. Welding of stiffening angles/vertical stiffening ribs as per drawings

b. Cutting to size and making holes to required shape wherever necessary

to allow service lines such as piping , cables etc to pass through

c. Splicing as shown in relevant drawings

d. Smoothening of edges

e. Fixing of chequered plates by welding and/or countersunk bolts

f. Providing lifting hooks for ease of lifting.

Cutting, heating or enlarging holes may be carried out only with prior written Approval from the ENGINEER.

FIELD CONNECTIONS:

Assembly by Permanent Bolts:

The number of washers on permanent bolts shall not be more than two(2) and not less than one(1) for the nuts and one(1) for the bolt head.

Only wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.

To prevent loosening of nuts, spring washers or lock-nuts shall be provided as specified in the design / shop drawings.

All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structure.

ASSEMBLY BY WELDING:

All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.

All other requirements of welding and its acceptance standards shall be in accordance with clauses specified in TCE.M4-405-01(Supply and Fabrication of structural steel).

Assembly by High Strength Friction Grip Bolts (HSFG Bolts)

Assembly of structures with HSFG bolts shall conform to IS:4000

The mating surface shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.

The mating surfaces shall be absolutely free from grease. Lubricant, dust, rust etc and shall be thoroughly cleaned before assembly.

The nuts shall be tightened up to the specific torque with the help of torquewrench or by half-turn method with the help of pneumatic wrench lever.

The direction of tightening of the nuts shall be from the middle towards the periphery of assembly.

After desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

INSPECTION

ENGINEER/OWNER or their authorised representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at CONTRACTOR's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by ENGINEER.

TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

COLUMNS

Deviation of column axes at foundation top level with respect to true axes

(a) In longitudinal direction: ± 5 mm

(b) In lateral direction: ± 5 mm

Deviation in the level of bearing surface of ± 5 mm

Columns at foundation top with respect to

True level

Out of plumbness (verticality) of column

Axis from true vertical axis, as measured at

Column top :

(a) For columns up to and including 15 ± 1/1000 of column height in mm or±15mm

Meters in height whichever is less.

(b) For columns exceeding 15 meters ± 1/1000 of column height in mm or±20mm

in height Whichever is less.

Deviation in straightness in ± 1/1000 of column height in mm or±10mm

Longitudinal and transverse planes of whichever is less.

Column at any point along the height

Difference in erected position of adjacent

Pairs of columns along length or across ± 10 mm

Width of building prior to connecting width

Of building prior to connecting

Trusses/beams with respect to true distance	
Deviation in any bearing or seating level	± 5 mm
With respect to true level	
Deviation in differences in bearing levels of	
a member on adjacent pair of columns both	± 10 mm
Across and along the building	
TRUSSES AND BEAMS	
Shift at the centre of span of top chord	± 1/250 of height of truss in mm or ± 15
Member with respect to the vertical plane	mm Whichever is less.
Passing through the centre of bottom chord	
Lateral shift of top chord of truss at the	
Centre of span from the vertical plane whichever passing through the centre of support of the truss	± 1/1500 of span of truss in mm or ± 15 mm whichever is less
Lateral shift in location of truss from its true	
Vertical position	± 10 mm
Lateral shift in location of purlin true	
Position	± 5 mm
Deviation in difference of bearing levels of	
Trusses or beams from the true difference	
	i) ±20 mm for trusses
	ii) For beams:
	Depth < 1800mm: ±6mm
	Depth > 1800mm: ±10 mm
Deviation in sag in chords and diagonals of	
Truss between node points	
	1/1500 of length in mm or
	10mm whichever is smaller

Deviation in sweep of trusses, beams etc in The horizontal plane	1/1000 of span in mm subject to a maximum of 10 mm

CRANE GIRDERS & RAILS

Shift in the centre line of crane rail with respect to centre line of web of crane girder	± 5 mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	± 5 mm
Difference in alignment of crane rail in plan measured between any two points 2 meters apart along rail	± 1 mm
Deviation in crane track with respect to time gauge	
(a) For track gauges up to and including 15 meters	± 5 mm
(b) For track gauges more than 15 Meters	± [5 + 0.25 (S-15)] where S in meters is true gauge
Deviation in the crane rail level at any Distance point from true level less	1/1200 of the gauge or ±10mm whichever is
Difference in the crane rail actual levels Between any two points 2 meters apart Along the rail length	± 2 mm
Difference in levels between crane track Rails at	
(a) Supports of crane girders	± 15 mm

(b) Mid span of crane girders ± 20 mm	2 mm subject to grinding of surfaces for
Relative shift of crane rail surfaces at a joint in plan and elevation	smooth transition.
Relative shift in the location of crane stops end buffers) along the crane tracks with gauge S in mm	1/1000 of track gauge S in mm subject to track maximum of 20mm

PAINTING

After steel has been erected, all bare and abraded spots, field welds, bolt heads and nuts shall be spot painted. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease.

CLEAN UP OF WORK SITE

During erection, the CONTRACTOR shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to OWNER/ENGINEER.

PAINTING OF STRUCTURAL STEEL

SCOPE

This specification covers the general requirements for shop and field painting for Structural Steel works using hot /cold rolled steel sections joined by using bolting and/or welding.

Briefly the scope of works covered under this specification are; i. Supply of all primers, paints and all other materials required for painting .

ii. Furnishing of all labour, materials, tools & equipment and the performance of all operations and incidentals necessary for surface preparation, painting, handling, storing, transporting, scaffolding etc.

iii. Testing of paints as per the relevant codes in the Standard Laboratory identified by the Owner and furnishing of required test certificates for Owner's approval.

iv. Repair work of damaged / pre-erection / fabrication shop primer and weld joints at field.

v. Inspection of painting system after its application to conform to the specification requirement.

vi. Any other requirement as required for satisfactory completion of specified work.

Reference shall be made to Data Sheet-A for Paint system and Data Sheet-B for the structures covered in the scope of works.

EXCLUSIONS

This specification excludes paintings of the following structures /equipment.

Mechanical & electrical equipment and parts.

i. Buried & Overhead piping works

ii. Storage tanks

iii. Insulated parts

Any other items of work specifically excluded in the scope of works.

APPLICABLE CODES, STANDARDS

The pertinent clauses of the following Indian / International Codes, Standards

And Specification (latest editions including all applicable official amendments,

Reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

Indian Standard Codes

1. IS:5 Colours for ready mixed paints and Enamels
2. IS:101 Methods of sampling and test for paints, varnishes

and related products (all parts & all sections).

3. IS:104 Ready mixed paint, brushing, zinc chrome, priming
4. IS:158 Ready Mixed paint, Brushing, Bituminous, Black,

   Lead free, Acid, Alkali and heat resisting.
5. IS:1303 Glossary of Terms relating to paints
6. IS:1477 Code of practice for painting of ferrous metals in Buildings.
7. IS:2932 Enamel, synthetic, exterior:(a) undercoating (b)

finishing- Specification

8. IS: 9954 Pictorial Surface Preparation Standards for Painting

of Steel Surfaces.

9. IS:13183 Aluminium paint, Heat resistant-specification.
10. IS:2074 Ready Mixed Paint, Air Drying, Red Oxide Zic

Chrome, Priming -Specification.

International Standard Codes

i. SSPC Society for Protective Coatings (USA) Volt I & II

ii. NACE National Association of Corrosion Engineers, USA(NACE)

iii. ISO 8501 Preparation of Steel Substrates before application of

Paints and related products. Visual assessment of

Surface cleanliness.(Part 1&2)

iv. ISO 8502 Preparation of Steel Substrates before application of

Paints and related products-Tests for assessment of

Surface cleanliness. (Part 1-4)

v. ISO 8503 Preparation of Steel Substrates before application of

Paints and related products-Surface roughness

Characteristics of blast-cleaned steel substrates. Part 1& 2

HEALTH, SAFETY AND REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by Owner.

CONTRACTOR shall ensure that all health and safety regulations are observed for the erection of scaffolding and use of the selected paint material.

All necessary precautions shall be taken to ensure the safety of personal and property. Extreme caution shall be used when working with oil or oil-based paints, cleaning fluids etc., especially in close proximity to oxygen piping or oxygen equipment. Heavy concentrations of volatile or toxic fumes must be avoided and in confined areas, blowers or exhaust fans shall be used.

Rags and other waste material soiled with paints, thinners or solvents shall be kept in tightly closed metal containers while on the jobsite and not in use. Legal disposal of waste materials outside plant site premises is Contractor's responsibility.

Lead being hazards material it is recommended to use lead free paint as per requirement of clause 3.6 of IS158.

SURFACE PREPARATION OF STEEL

One or more of the following methods of surface preparation shall be followed, depending on condition of steel surface and as specified in the data sheet. ENGINEER reserve the right to instruct the type of surface preparation depending upon the condition of material. Recommended methods of surface preparation of steel briefly are as under.

a) Solvent Cleaning.

b) Manual or hand tool cleaning.

c) Mechanical or power tool cleaning.

d) Abrasive Blast cleaning.

It is necessary that the CONTRACTOR shall have to resort to any one or combination of the above method of surface preparation to achieve the required acceptable standard. Hence the rate quoted shall take into account for such preparation.

SOLVENT CLEANING

All contaminants like oil, grease removal shall be carried out either by special solvents or by degreasing agents. Application and cleaning of solvents shall be as per manufacturer's instructions and shall be in accordance with SSPCSP1.

MANUAL OR HAND TOOL CLEANING

This method of cleaning shall be used to remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by use of nonpowered hand tools. The minimum acceptable standards in case of manual or hand tool cleaning shall be in accordance with ISO 8501- St2 / SSPC-SP2.

MECHANICAL OR POWER TOOL CLEANING

This method of cleaning shall be used to remove all mill scale, rust, paint and other detrimental foreign matter by use of power assisted hand tools. The minimum acceptable standards in case of power tool cleaning shall be in accordance with ISO 8501- St3 / SSPC-SP3.

ABRASIVE BLAST CLEANING (SHOT BLASTING / GRIT BLASTING)

Shot / Grit blasting shall be resorted to only after removal of grease, oil and other contaminants as per SP-1. Special care shall be taken on weld areas to remove flux and spatter. Precautions shall be taken when grit or shot blasting of light gauge steel surfaces, to ensure that buckling does not occur due to continuous impingement of grit or steel shots under high velocity. Surface anchor profiles shall be measured by Testex tape – press-o-film and the finished surfaces shall conform to the requirements of ISO 8501- Sa 2½ / SSPC-SP10.

Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

TESTS ON SURFACE PREPARATIONS

The following inspection and tests shall be performed on the steel surfaces subjected to surface preparation. Test / inspection reports shall be submitted to ENGINEER for his approval and acceptance.

i. Visual examination of surface preparation with comparators.

ii. Profile check of the prepared surface with suitable "profilometer "eg.TESTEX method.

PAINT MATERIAL

PROCUREMENT

All types of paints required for the work shall be as per the requirement of relevant IS codes and procured from the reputed manufacturers. Contractor shall obtain the detailed list of approved paint manufacturers from the ENGINEER before initiating the procurement action.

STORAGE

The Paint material shall be stored strictly in accordance with the instructions of the paint manufacturer. In general painting materials should be stored in dry, cool, well ventilated and frost free area.

PACKING

All paints delivered to the fabrication shop / site shall be in original sealed container, as packed by the manufacturer. Paint containers shall clearly mark with paint manufacturer's name, batch number, date of manufacture, shelf life and a clear indication of the type and colour of the product.

MIXING

Paint shall be thoroughly mixed prior to application. Mixing shall be done in a well-ventilated, clean and dust -free area. Paint shall be mixed by rotating power mixers or rolling rigs, until a uniform consistency is achieved. Multiple pack paint materials shall be mixed in accordance with and under the conditions as specified by the paint manufacturer. Pot life as specified by the Paint manufacturer shall be strictly followed.

THINNER AND SOLVENTS

Only additives, thinners, solvent etc as recommended by the paint manufacturer shall be used. A possible extension of the "pot life" by addition of thinners is prohibited.

TESTS ON PAINT

In order to ensure that the supplied paint meets the stipulations, samples of paint shall be tested in laboratories to establish quality of paint with respect to

i. Viscosity.

ii. Adhesion/ bond of paint in steel surfaces.

iii. Adhesion / simulated salt spray test.

iv. Chemical analysis (percentage of solids by weight)

v. Normal wears resistance as encountered during handling & erection

vi. Resistance against exposure to acid fumes etc.

Alternatively manufacturer's test certificates shall be furnished by the Painting CONTRACTOR in respect of above tests for ENGINEER's approval and acceptance. ENGINEER reserves the right

to test the paint material either before the commencement of work or during the progress of work if in his opinion the paints supplied are of inferior quality and does not meet the codal provisions.

REQUIREMENTS

PAINT SAMPLE

Before buying the paint in bulk, it is recommended to obtain sample of paint and establish “Control Area of Painting”. On control area surface preparation, painting shall be carried out in the presence of Engineer and the Manufacturer of paint.

FINISHING PAINT

Colour /Shade of the finishing paint shall be as per the choice of the Owner and Contractor shall obtain prior approval before procurement action is initiated.

PAINT APPLICATION

Painting shall be carried out by any one or the combination of the following method of application to suit the site condition and the type of paint being used. Manufacturer’s recommended method of application shall be strictly followed.

i. Brush Application.

ii. Roller Application.

iii. Spray Application.

BRUSH APPLICATION

Brush application of paint shall be in accordance with the following.

i. Brushes shall be of a style and quality that will enable proper application of paint

ii. Round, Oval or Wide flat brushes shall be used depending upon the surface irregularity, rough or pitted steel, large flat painting areas etc

iii. There shall be a minimum of brush marks left in the applied paint.

iv. Surfaces not accessible to brushes shall be painted by spray.

ROLLER APPLICATION

Suitable rollers of different nap length to suit varying surface roughness shall be used. Rollers are not generally recommended for application of primers. Roller application shall only be used if the first or priming coat of paint has been applied by brush or other means. Manufacturer’s recommendation shall be strictly followed for roller applied paints.

SPRAY APPLICATION

Airless or pneumatic spray application shall be in accordance with the following

i. Airless spray application shall be as per steel structure paint Manual Vol 1& Vol 2 SSPC, USA.

ii. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90 0 to the surface being painted.

iii. Correct spray tips, air pressures etc as recommended by the equipment supplier shall be adopted.

Air spray application shall be in accordance with the following:

i. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges.

ii. Appropriate pressure and nozzles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

iii. Correct combination of air volume, air pressure and fluid flow to give good atomization shall be ensured to get a defect free painted surface.

iv. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

v. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

vi. Spray equipment shall be kept sufficiently clean so that dirt, dried paint and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

Selection of type of spray application shall depend upon the type of paint coating being used. At all time paint manufacturer's recommendation shall be strictly followed.

COATING PROCEDURE

COMPATIBILITY

General Compatibility between primer, intermediate and top coats, as applicable for individual painting system shall be established through the paint manufacturer supplying the paints. Primer and finishing paint for the entire project shall preferably be procured from the same manufacturer. Mixing of material from different manufacturers is strictly prohibited

Surface shall not be coated in rain, wind, when steel surface temperature is less than 50 C, or when the relative humidity is greater than 85%.

Applied paint system shall be allowed to cure at ambient and surface temperatures between 10 ° C and 60 ° C with relative humidity below 85%. All paint shall be air curing.

6.8.4. A suitable test area (approx 0.5 m2) shall be painted with agreed paint system. The test area shall be fully coated with all coats of the agreed coating system using the tools and equipment to be used for the actual coating work. The painted test area shall be maintained for

the duration of the project. Painting on test piece shall be carried out such that all the coats shall be made visible for reference at all time.

Structural steel shall be preferably prime coated at shop and subsequent finish coats shall be carried out at site after the alignment and erection is complete. Portions of structural steel members to be embedded into the concrete shall not be painted.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating / chequered plate /RC Slabs shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Each coat of paint material shall be applied as continuous film uniform thickness free of pores. Any spot or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer's instruction shall be strictly followed for intercoat intervals.

No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores or detrimentally affect the condition of the paint.

No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

Paint shall be protected from rain, condensation, contamination, snow and freezing until dried to the fullest extent practicable.

Blast cleaned surface shall be coated with one coat of primer before surface degradation occurs but in no case later than 3hrs. Irrespective of the method of surface preparation, the first coat of primer shall be applied not later than 2- 3 hours after preparation and on dry surface.

When the successive coat of the same colour is specified, alternate coat shall be tinted as far as practicable; sufficient to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

All field welded areas on shop painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer, intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

Care shall be taken to protect adjacent equipment, piping, structures etc., from spillage and spatter during field painting by use of adequate temporary covers. If surfaces are accidentally spattered or sprayed, the paint shall be immediately and thoroughly removed. For cleaning of spillages an inert absorbent material shall be used.

All structures shall receive appropriate number of primer, intermediate and finishing coats in order to achieve overall DFT as per the drawings / specifications/ data sheets.

PAINTING SYSTEM

The recommended painting system of all Structural Steel Works covering surface preparation, application of Primer coats, Intermediate coats (if specified) and Final coats to develop required minimum DFT shall be as per painting guide.

REPAIR OF COATED SURFACE

Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

If more than 30% area of the painted surface of an item requires repair, the entire surface shall be repainted. In such an event no extra payment will be permitted.

TEST ON PAINTING SYSTEM

Following inspection and tests shall be performed during and after the application of paint system.

i. Wet film thickness (WFT) spot checks shall be carried out during the course of painting operation to ensure that film thickness is being maintained.

ii. Dry film thickness (DFT) check of intermediate and final coating layers in accordance with the specification and /or paint manufacturer's recommendation.

iii. Quality of adhesion between the coating system and the steel substrate and of the adhesion between the coatings layers shall not be less than those specified in the Codes / Standards.

iv. Porosity Check: Holiday detection test shall be carried out and all indications shall be repaired as per approved repair procedures.

FINAL INSPECTION

As part of the Quality Assurance, a final inspection in the presence of the representatives of OWNER and CONTRACTOR shall be conducted prior to the final acceptance of the paintwork. Part of this final inspection checks shall be

i. Visual check of the appearance.

ii. Checks on DFT's of the total applied coating system.

iii. Shade verification.

iv. Holiday Testing.

v. Scratch Test.

vi. Adhesion test.

As part of acceptance procedure, a report shall be prepared that shall include:

i. General:

 Names of the Painting Contractor and the responsible personal

 Scope of work

 Dates when the work was carried out.

 Copy of the work and quality plan

 Deviations from this Specification and/or the quality plan.

ii. Inspection equipment

 Type and calibration of instruments used.

iii. Surface Preparation

 Condition of surface before preparation

 Checks on the requirements as specified for cleaned surface.

iv. Coating application

 Information on coating systems being applied (i.e. product names,

DFT's)

 Checks on requirements as specified for coating application

 Check on dry film thicknesses of the total coating system applied

v. Conditions

 Checks on humidity, dew point and substrate temperature.

vi. Inspection reports

 Copy of the inspection reports of the Contractor

 Inspection from an independent third party

DOCUMENTATION

Contractor shall keep records and furnish the following documents to the Owner

i. A written quality plan with procedure for qualification trials and for the actual work.

ii. Daily progress report with details of weather conditions, particular of applications, number of coats and type of material applied, anomalies, progress of work versus program.

iii. Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

iv. Particulars of surface preparation and paint application during trials and during the work.

v. Details of non-compliance, rejects and repairs.

vi. Type of testing equipments and calibration.

vii. Code and batch numbers of paint materials used including shelf life.

viii. Visual examination of surface preparation compared with the standards.

ix. Profile check of the prepared surface with suitable “profilometer.

x. Dry film thickness check of intermediate and final coating layers, in accordance with the specification and/or paint manufacturer’s recommendation.

xi. Checks/ tests carried out as per clauses above.

GUARANTEE

The paint system shall provide sufficient protection of the underlying steel surface against the attack of the environment, other than mechanical damage, chemical spillage as result of operational activities or other unusual occurrences from the outside caused by others.

The CONTRACTOR is fully responsible for the quality of the work and for all related QA/QC activities as indicated in the specification.

The CONTRACTOR shall guarantee quality of their coating works for the period specified in Data Sheet-B and for the coating condition as specified below.

The guarantee period starts from the date of acceptance of CONTRACTOR’s paint work.

Initial acceptance of any new coating work by OWNER will not release the CONTRACTOR of his obligation under this section until final inspection has been carried out and acceptance of the completed work has been agreed in writing.

These guarantee clauses regarding coating specifications are prevailing and supersede the warrantee requirements in General Conditions of Contract.

DATA SHEET A

PAINT SYSTEM

Paint System	Surface Preparation	Primer Coat (µm)	Intermediate Coat (µm)	Top Coat (µm)	Dft (µm)
PS-1	St-2	Inorganic Zinc Phosphate		Synthetic Enamel	
		2x35=70		2x25=50	120
PS-2	Sa 2 ½	Inorganic Zinc Silicate		HB Epoxy Polyamide (pigmented)	
		1x75 =75		1x75=75	150
PS-3	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aromatic Polyurathane Acid Resistant	
		1x75 =75	1x75=75	1x50=50	200
PS-4	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	1x75=75	225
PS-5	Sa 2 ½	Inorganic Zinc Silicate		Aliphatic Polyurathene(UV Resistant)	
		1x75 =75		1x50=50	125
PS-6	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	1x75=75	225
PS-7	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aromatic Polyurathane Acid Resistant	
		1x75 =75	1x75=75	2x50=100	250
PS-8	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	2x75=150	300
PS-9	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aliphatic Polyurathene(UV Resistant)	
		1x75 =75	1x75=75	1x50=50	200
PS-10	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	2x75=150	300
PS-11	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aromatic Polyurathane Acid Resistant	
		1x75 =75	1x100=100	2x50=100	275
PS-12	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	2x75=150	2x75=150	375
PS-13	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aliphatic Polyurathene(UV Resistant)	
		1x75 =75	1x75=75	2x50=100	250
PS-14	Sa 2 ½	Inorganic Zinc Silicate or Epoxy Zinc Rich		Heat resistant -Silicon Based aluminium paint	
		1x75=75		1x40=40	115

TECHNICAL SPEIFICATIONS FOR THERMAL INSULATION FOR ROOF

SCOPE

OVERDECK INSULATION:

This specification covers the requirements of thermal insulation over the RCC top slab (terrace slab/ sloping roof slab) including its fixing arrangement. The insulation system is called as 'inverted roof insulation system' in which the insulation layer is placed over the waterproofing layer that has been laid on the RCC slab. It is commonly also known as 'over deck insulation'.

BENEFITS:

The inverted roof concept has other benefits, it can be installed in any weather, added without stripping the waterproof layer, easily lifted and replaced/re-used if the building is altered.

UNDERDECK INSULATION:

This specification covers the requirements of thermal insulation under the RCC roof or top slab (terrace slab) including its fixing arrangement.

Thermal insulation shall be engineered resin bonded fibrous insulation to offer maximum resistance to heat passage. The thickness of material should be in range of 50 to 75mm. as approved by the Engineer-in-charge. The insulation shall be provided after the sample is approved by the Engineer-in-charge.

Thermal insulation material consisting of boards, slabs and rolls of approved manufacture, shall be of approved thermal conductivity as per manufacturer's data sheet for creating the required design conditions, and shall be provided as specified in item of works and as shown in the drawings. The insulation shall be provided after the sample is approved by Engineer-in-charge.

OVERDECK INSULATION (RCC SLOPING ROOF AND FLAT ROOF)

APPLICABLE CODES & STANDARDS

ASHRAE/IESNA Standard 90.1-2004, Appendix G - Energy Standard for Buildings except Low-Rise Residential Buildings

ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

GRIHA-IV Abridged Versions

MATERIALS

XPS Board

Thermal insulation shall be engineered extruded polystyrene (XPS) foam insulation designed to offer maximum resistance to heat passage. The board has smooth, high-density skins, with closed cellular structure. It is produced by a continuous, fully automated extrusion process. It has excellent mechanical properties like insulating characteristics (R-value of 5.0 per inch of thickness), low water absorption, uniform density distribution, dimensional stability, excellent compressive strength, aging resistance, immunity against insects, bacteria, rodent attacks. The thickness of material should be in range of 50 to 75mm. as approved by the Engineer-in-charge. The insulation shall be provided after the sample is approved by the Engineer-in-charge.

Insulation material consisting of boards/ slabs of approved manufacturer, thermal conductivity as per manufacturer's data sheet for creating the required design conditions shall be provided as specified in item of works and as shown in the drawings.

widely available sizes are width = 600 mm, length = 1250mm and thickness= 20-100mm. Edge profile is square edge, shiplap

ADHESIVES

FIXING ACCESSORIES

WORKMANSHIP/ INSTALLATION

Roof Deck Preparation:

Clean the slab surface thoroughly with wire brush to make it free from dust and loose particles. Treat all the cracks (wider than hairline) and construction joints by routing out to a minimum 3/4" x 3/4" groove and filling it with a specialised sealant of approved make. Treat the honeycombs by routing out the loose concrete upto the sound concrete and grouting with specialised non-shrink cementitious compound, curing thoroughly.

WATERPROOFING MEMBRANE:

Lay over the entire slab area the elastomeric membrane waterproofing system of approved make as per manufacturer's specification as approved by the Engineer-in-charge and supervision of manufacturer along with the site engineer. The membrane shall have elongation of 300% and UV resistance. The membrane shall be raised till 450mm height on the parapet wall along the periphery.

INSULATION:

Lay extruded polystyrene sheet of 75mm. thickness and approved size with necessary lap joint, anchors, adhesives, primers as per manufacturer's specification and under his supervision along with the site engineer.

PROTECTIVE COVER/ SEPARATION LAYER:

Lay the geo-textile fabric of 0.075 mm thickness with min. 75mm overlap at edges as a separation layer on top of insulation.

PRE-FINISHING LAYER:

To create a slope of specified gradient, lay as per the specification average 75mm thick of screed concrete of M20 grade mixed with water-proofing admixtures and its curing. Treatment also to continue on the parapet wall up to 300 mm height along the periphery in shape of round slope and curing.

The u-value to be achieved as per Appendix G of ASHRAE/IESNA Standard 90.1-2004 should be in the range of 0.063 Btu/hr.ft2.ºF.

STORAGE, HANDLING & DELIVERY

Material received at site shall be with original packing, labels, batch dates. It shall be untouched/ intact till issued for use of site.

Material shall be stored at properly covered dry location and shall be safe from any sort of physical damage.

Cartons must always be stored with designated side upwards.

FINISHING

The finishing layer over the screed can be of china mosaic helping to reduce heat island effect.

SUBMITTALS AND TESTING

The submittals by the contractor shall include:

Samples of all boards/ slabs for approval of the Engineer-in-charge.

Literature / catalogue of product to be used including data sheet covering technical literature.

Manufacturer's certification that product meets/ exceeds specification for the project.

The contractor shall also submit the test certificates for physical, chemical and fire resistant properties of the materials.

MOCK-UP

The contractor shall prepare and install mock-up samples as per approved shop drawings.

Mock-up samples shall be of full size and shall be true representation of actual works to be carried out at site. Mock-ups may be part of completed work if undisturbed.

UNDERDECK INSULATION (RCC SLOPING ROOF AND FLAT ROOF)

APPLICABLE CODES & STANDARDS

ASHRAE/IESNA Standard 90.1-2004, Appendix G - Energy Standard for Buildings Except Low-Rise Residential Buildings

ECBC-2007

BS 476 - Fire tests on building material

IS: 8183 - Bonded mineral wool

GRIHA-IV Abridged Versions

MATERIALS

Glass wool Board

Thermal insulation shall be engineered resin bonded fibrous insulation to offer maximum resistance to heat passage. The thickness of material should be in range of 50 to 75mm. as approved by the Engineer-in-charge. The insulation shall be provided after the sample is approved by the Engineer-in-charge.

Thermal insulation material consisting of boards, slabs and rolls of approved manufacture, shall be of approved thermal conductivity as per manufacturer's data sheet for creating the required design conditions, and shall be provided as specified in item of works and as shown in the drawings. The insulation shall be provided after the sample is approved by the Engineer-in-charge.

ADHESIVES

FIXING ACCESSORIES

GYPSUM BOARDS

WORKMANSHIP/ INSTALLATION

Clean the surface thoroughly with wire brush to make it free from dust and loose particles. Apply adhesive on the RCC surface as well as on the insulation material. Allow both surface to dry but in sticky condition. 50 mm thick (or upto 75mm as advised by the Engineer-in-charge) under deck insulation material conforming to IS:8183 (such as Rockloyd/ Twiga boards or approved equivalent) having a minimum density of 32 kg/m3 and faced with 0.05 mm minimum thickness aluminium foil and 24GX25 mm wire mesh netting (facing done either at factory preferably, or at site) to be installed under concrete roof including all connected works such as, but not limited, to providing slotted angle pieces with rawl plugs and coach screws for fixing the insulation to roof.

Fix the insulation under RCC surface and press it in position.

14G GI tie wires in criss-cross arrangement in angle cleats and 24 SWG x 25 mm square, wire mesh netting shall be provided at the bottom to ensure intimate contact with the underside of roof. These joints shall be sealed with aluminium adhesive tape suitably as required.

WORKMANSHIP/ INSTALLATION FOR THERMOCOLE BOARDS

Soffit of R.C. slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 kg/m2.

Thermocole boards (T.F. variety) of 50 mm thickness shall be stuck by means of the same grade of hot bitumen.

The boards shall be further secured with screws, washers and plugs.

The joints of the boards shall be sealed with bitumen.

The net superficial area of the insulation shall be measured and paid.

WORKMANSHIP/ INSTALLATION FOR FIBRE GLASS BOARDS

Timber pegs 50 mm x 50 mm x 50 mm shall be fixed to the slab at 600 mm centres with 6 mm x 65 mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.

‘Crown’ 200 fibreglass boards 50 mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

The insulation boards shall be covered with 20 mm – 24 gauge hexagonal G.I. chicken wire meshes, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wire mesh with 50 mm overlap and secured to the timber pegs by screws.

If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the frame work. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

The net superficial area of the insulation shall be measured and paid for.

STORAGE, HANDLING & DELIVERY

Material received at site shall be with original packing, labels, batch dates. It shall be untouched/ intact till issued for use of site.

Material shall be stored at properly covered dry location and shall be safe from any sort of physical damage.

Cartons must always be stored with designated side upwards.

FINISHING

12 mm thick gypsum boards to be fixed underside of the insulation layer. The gypsum board to be painted with acrylic emulsion pain of approved shade.

SUBMITTALS AND TESTING

The submittals by the contractor shall include:

Samples of all types, boards, slabs or rolls, for approval of the Engineer-in-charge.

Literature / catalogue of product to be used including data sheet covering technical literature.

Manufacturer's certification that product meets/ exceeds specification for the project.

The contractor shall also submit the test certificates for physical, chemical and fire resistant properties of the materials.

7.3.9. MOCK-UP

The contractor shall prepare and install mock-up samples as per approved shop drawings.

Mock-up samples shall be of full size and shall be true representation of actual works to be carried out at site. Mock-ups may be part of completed work if undisturbed.

UNDERDECK INSULATION (FOR ROOF SHEETING IN PEB)

APPLICABLE CODES & STANDARDS

IS 8183 : 1993 - Bonded Mineral Wool.

BS standard BS 476 : Part 4 - Non combustible.

BS 476: Part 5 - Not easily ignitable/Class P.

BS 476: Part 6 - Fire propagation.

BS 476: Part 7 - Surface spread of flame (Class 1), Class 'O' as per BS 476 part 6 & 7 together.

MATERIALS

Fibre Glass Wool Insulation: Insulation material shall comply with IS-8183 and shall be lightweight blanket of bonded fibre glass wool insulation of approved make by the Engineer-in-charge of density 24 kg/ m3 and 50 mm thickness (any other suitable density and thickness options with suitably factory laminated with one side WMP – 50 facing or any other suitable facing may be considered) Insulation material shall have thermal conductivity value of 0.033 W/mK and shall be non toxic, low smoke emitting, chemically inert and free from impurities like sulphur, chloride and metal shots. Material having steel plants slag shall not be acceptable.

Important Factor to be considered while selecting insulation material -

Material shall be inorganic, chemically inert, non-toxic and shall not use any slag i.e. steel plant wastage during manufacturing.

Material shall be free from any shot content, chloride, sulphur.

Material shall be lighter in weight as possible like e.g. 1.2 kg per sq.m.

Material shall have Low Thermal Conductivity value 0.033 W/ M.K @ 25 deg C mean temperature.

Material shall have high Noise Reducing Coefficient (NRC) value - 0.9 to 1.0

Material shall be non-combustible & classified as highest fire Class O as per British Standard BS

Adhesive double-side tapes (min. 5 cm width)

Adhesive repair tape with facing.

Wire net.

WORKMANSHIP/ INSTALLATION

. Option – I , Single Skin Application.

Insulation of desired density and thickness with suitable factory laminated foil to be placed over weld mesh of size 75mm x 75 mm x1.6 mm GI mesh. Facing should be on downward direction. The 50 mm facing projections/ flange to be used as overlaps to join the rolls together. Then roofing sheet to be fixed over the insulation to the purlins with the help of mechanical fasteners or with standing seam system.

Option II, Double Skin Application: Insulation of the desired density and thickness to be used between two metal sheets with sub guard.

STORAGE, HANDLING & DELIVERY

The insulation should be inspected upon arrival at the job site to ensure that it is exactly as ordered. If there is anything wrong with the insulation, it should not be installed. Contact the supplier immediately.

Insulation should be stored in a dry, protected area. Stack height should not be more than 3 rolls. Rolls should be placed horizontal.

All packages should be elevated above the ground or slab, preferably on a flat surface, to prevent contact with surface water accumulation. The facing should be protected from tears and punctures to maintain continuity of the vapour retarded.

Poly-bags should have holes in each end to aerate the insulation. It is also suggested that the contractor open the ends of the bags to allow better air circulation around the insulation.

Packages can be left uncovered during the day, weather permitting, but should be protected at night with polyethylene film, canvas or other covering.

Whenever possible, the insulation should be used as soon as possible after it arrives at the job site. The sooner the insulation is installed, the less likely it is to get damaged in storage.

FINISHING

Preferable Facing / Backing Options given below for PEB Building :

Aluminium Based Facing -

Aluglass Facing (Aluminium Foil backed by Glass Cloth)

HSMAF - High Strength Mesh less Aluminum Facing

Aluminium Foil

Aesthetic facing -

WMP – 50 / High strength Ultimate White Facing

WMP VR – 30 Facing,

WMP VR – 10 Facing,

WMP VR Facing

SUBMITTALS AND TESTING

Standard Test method carried out for various parameter as per IS 3144 like density, thickness, dimensions, moisture, sulphur and shot content, incombustibility etc. whereas thermal conductivity can be tested in third party testing laboratory.

MOCK-UP

The contractor shall prepare and install mock-up samples as per approved shop drawings.

Mock-up samples shall be of full size and shall be true representation of actual works to be carried out at site. Mock-ups may be part of completed work if undisturbed.

TECHNICAL SPECIFICATIONS FOR HEAT, VENTILATION, AIR CONDITIONING SYSTEM

AIR-CONDITIONING SYSTEM

Variable Refrigerant Flow (VRF) type air-conditioning system has been considered to meet the air-conditioning requirements of the above buildings. Outdoor units shall be located at the Terrace of the respective building. No stand-by units has been considered for selection of outdoor / indoor units.

INSIDE DESIGN CONDITIONS

Inside design temperature at 24 ± 1 °C DBT & RH of upto 70 % shall be considered for cooling load estimation.

AREAS TO BE AIR CONDITIONED & TYPE OF UNITS

Air-conditioning shall be considered for the various areas as indicated below along with details of AC indoor (IDU) & outdoor (ODU) units.

Sl. No.	Location	Total Dehumidified Air Quantity (CMH)	Total TR	IDU Quantity (Nos.)	Type of IDU	Total ODU Capacity (HP)
	Auditorium Building					
1.0	Ground Floor					
	Reception, Cafeteria, Dining, Waiting & Lobby Area (S-E Side)		3 TR X 25 Nos.		4-way Cassette	94
	Convention Hall - 1	16,000	21	1	Floor Mounted Ductable AHU	26
	Convention Hall - 2	16,000	21	1	-Do-	26

Sl. No.	Location	Total Dehumidified Air Quantity (CMH)	Total TR	IDU Quantity (Nos.)	Type of IDU	Total ODU Capacity (HP)
	Auditorium – Seating Area-1	23,800	55	5	-Do-	70
	Auditorium – Seating Area-2	23,800	55	5	-Do-	70
	Auditorium – Stage & Participant Waiting Area	10,200	15	1	-Do-	42
	VIP Waiting & Lobby Area (N-W Side)		2 TR X 5 Nos.		4-way Cassette	
	Green Room – Female (N-W Side)		2 TR X 2 Nos.		-Do-	
	Green Room – Male (N-W Side)		2 TR X 2 Nos.		-Do-	
2.0	First Floor					
	Guest Rooms, Office & Lobby Area (N-W Side)		3 TR X 7 Nos.		-Do-	26
	Guest Rooms & Lobby Area (S-E Side)		3 TR X 16 Nos.		-Do-	60
3.0	Second Floor					

Sl. No.	Location	Total Dehumidified Air Quantity (CMH)	Total TR	IDU Quantity (Nos.)	Type of IDU	Total ODU Capacity (HP)
	Projection Room & Lobby Area (S-E Side)		3 TR X 12 Nos.		-Do-	45
	Command Control Centre (CCC)					
1.0	Ground Floor					
	Waiting & Reception Area, Cafeteria, Conference Room, ICT/LV Room, Citizen Service Counters	27,000	30	1	Floor Mounted Ductable AHU	38
2.0	First Floor					
	Waiting Area, Manager's Cabins, Call Centre, Staff Seating Area, Conference Room, Office Cabins & Work Station Areas	30,500	36	1	Floor Mounted Ductable AHU	45
3.0	Second Floor					
	CEO Cabins, Staff Seating	29,000	35	1	Floor Mounted	44

Sl. No.	Location	Total Dehumidified Air Quantity (CMH)	Total TR	IDU Quantity (Nos.)	Type of IDU	Total ODU Capacity (HP)
	Area, Training Room, Office Areas & Meeting Room				Ductable AHU	
4.0	Third Floor					
	DC Server Farm Area, Material Handling Room, UPS and Battery Room, Board Room, VIP Lounge	28,000	31	1	Floor Mounted Ductable AHU	40
5.0	Fourth Floor					
	Command & Control Room, Board Room, Teleconference Room	31,500	35	1	Floor Mounted Ductable AHU	44
6.0	Fifth Floor					
	Board Room, Teleconference Room & Other Areas	19,000	22	1	Floor Mounted Ductable AHU	28
	Tribal Museum					
1.0	Ground Floor					

Sl. No.	Location	Total Dehumidified Air Quantity (CMH)	Total TR	IDU Quantity (Nos.)	Type of IDU	Total ODU Capacity (HP)
	Reception, Display Area, Tribal Hut, Office area	20,500	45	1	Floor Mounted Ductable AHU	56
		20,500	45	1	Floor Mounted Ductable AHU	88
2.0	First Floor					
	AV Room		4 TR X 2 Nos.		4-way Cassette	
	Waiting Lobby with Display		2.5 TR X 2 Nos.		-Do-	
	Library		4 TR X 3 Nos.		-Do-	
3.0	Second Floor					
	Halls, Workshop & Hockey Hall of Fame display area	26,000	50	1	Floor Mounted Ductable AHU	63
		26,000	50	1	Floor Mounted Ductable AHU	63

Notes:

- Capacity of Air-conditioning equipment mentioned above are indicative & for reference only. Exact capacity & quantity of each item shall be finalised based on detail heat load calculations during engineering stage, to be submitted by the Contractor, as per latest architectural drawings and equipment heat loads of respective area.
- Static pressure AHUs shall be calculated by the Contractor based on layout drawing & to be submitted for approval during engineering stage.

- Exact location of respective ODU shall be finalised during engineering stage, based on latest architectural drawings & fulfilling architectural requirements.
- Any additional area requiring air-conditioning as per architectural drawings during engineering stage, shall be considered without any price implications.

EQUIPMENT SPECIFICATION

Details of AC equipment shall be as indicated below:

VRF UNITS

Variable Refrigerant Flow (VRF) type system has been proposed to meet the air-conditioning requirements. The indoor and outdoor units shall be inter-connected by insulated refrigerant copper piping and electrical cabling. Access doors shall be provided for volume control dampers installed in branch ducts for service and maintenance purpose.

The Air cooled full inverter VRF outdoor units shall be factory assembled, powder coated GI sheet metal cabinets, all hardware of anti-rust quality, conformal coating on PCB to protect from duct & humidity, hydrophilic blue fin material for better corrosion resistance with Brushless DC Motor only. Outdoor Units shall be top discharge type or as per site requirement.

VRF outdoor unit must have bigger condenser coil face area with higher capacity fan resulting in improved efficiency, less deration due to higher ambient temperatures.

The outdoor unit must consist of Inverter Scroll Compressor only. Each outdoor unit shall consist of single / multiple full inverter Scroll compressors. There should not be any fixed compressor or Partial inverter.

The VRF system must compatible with R410A / R407C / Eco friendly green Refrigerant only. System must be pre-charged at Factory. If required additional, based on the site, then it will be charged additional at site.

All Inverter VRF must be designed with the new generation Refrigerant Cooled PCB, which helps maintain the drive within allowable temperature range. It enhances the reliability of the system when it is working under very high ambient conditions.

Each indoor unit must be connected (with VRF outdoor unit) by means of individual Copper Refrigerant network or Y distribution joints only. The mentioned “Y” joint or refnet joints must factory make & tested by OEM. The individual size of refnets or “Y” joints connecting to individual indoor units, to be calculated & supplied by OEM / Bidder / OEM approved bidder only.

All Inverter VRF should have emergency back operation. In-case of double compressor ODUs, it must operate or function even if there is a failure or maintenance downtime of one compressor.

In modular VRF, where multiple units have been combined to run, as one larger unit, the system must operate even in case of failure or maintenance downtime or shutdown of one VRF ODU. It will help to ensure that cooling remains largely unaffected even during servicing.

As all the indoor units are interconnected by the communication cable, if there is any break in any communication cable, subsequent IDUs are affected and must not function. By activating the IDU emergency operation on the Next Generation All Inverter VRF, the other IDUs must function despite of such break.

Indoor Units:

Ductable Indoor Unit - Floor Mounted Double Skinned AHU, compatible with VRF outdoor units, shall consist of the following and having extruded Aluminium section frame construction, Outer Skin with 0.6 mm thick Pre-coated GI, Inner Skin with 0.6 mm thick Plain GI, Insulation with 25 mm thick PUF of density 40kg/ Cu. Mtr. AHU shall also consists with the following:

Fan Section with Forward/Backward curve fan having required capacity of TEFC Sq. Cage Induction Motor (EFF-1)

Coil Section with 6 Row deep DX Cooling Coils

Filter Section comprises of Washable Pre-filter (Efficiency 90% down to 10 Microns)

Sandwich Drain Pan with 25mm thick PUF injection in between 22G SS Inner & 24G GI Outer Sheet

Mixing Chamber

Cassette type Indoor Unit - The indoor units shall be ceiling suspended 4-way cassette type with electronic expansion valve, inbuilt drain connections, stainless steel (18G) drain pan with PUF insulation, drain pump, pre-filter, fan section, DX cooling coil section & wireless remote.

Refrigerant piping:

The Refrigerant pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangements shall be in accordance with good engineering practice as applicable to the air-conditioning industry, and shall include charging connections, suction line

insulation and all other items normally forming part of proper refrigerant circuits except Y-joint/separation tubes.

Before joining any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specify by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to a vacuum of not less than 700 mm Hg and held for 24 hours.

The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit the thickness of copper piping shall not be less than 18 SWG for pipes upto 19.1 mm and 16 SWG for larger dia.

The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fastener, brackets and supports from the building/structure.

The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner by making appropriate boxing arrangement matching with the interior of the room. All associated minor Civil Engineering works (like chasing on wall, ceiling & re-plastering and repainting etc.) related with the above items are to be included .

Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies etc. Shall be insulated with 19-mm/ 13 mm thick elastomeric Nitrile rubber as applicable.

Fresh air shall be drawn into AHU room by means of intake air louvers through pre- filters. The air filter shall be 3 Ply HDPE (pleated construction) with GI/Aluminum frame of preferable size 610 x 610 x 50 mm thick. The filter shall be housed in a frame with GI intake louver. The efficiency of filter shall be 90% down to 10 micron dust. The face velocity of filter shall not be more than 2.5 m/s. The quantities of the filters shall be as per the fan capacity envisaged.

Insulated condensate drain from each indoor unit shall be terminated to the nearest drain/nearby pantry/ toilet wash basin block/risers at each floor.

VENTILATION SYSTEM

AREAS TO BE VENTILATED

Dry type mechanical ventilation system shall be considered for different areas at individual floors, as mentioned below:

Sl. No.	Location	Air Qty	Qty	Type of Exhaust Fan
	Auditorium Building			
1.0	Basement Floor			
	Car Parking Area	As per layout requirement	6	Dual speed exhaust fans along with ductwork
	Store Rooms	9,500	2	Tube axial Fan
	STP area in basement	As per layout requirement	1	Dual speed exhaust fans along with ductwork
2.0	Ground Floor			
	Toilets	6,000	4	Ceiling suspended Ducted Cabinet Fan
	Kitchen	10,000	2	Ceiling suspended Ducted Cabinet Fan
	Electric Room	12,500	1	Tube axial Fan
3.0	First Floor			
	Small Toilets inside Guest rooms	700	10	Propeller Fan
	Electric Room	12,500	1	Tube axial Fan
	Store Room & Kitchen	4,000	2	Tube axial Fan

	Command Control Centre (CCC)			
1.0	Ground Floor			
	Toilets	5,000	1	Ceiling suspended Ducted Cabinet Fan
	Electrical Room	7,500	1	Tube axial Fan
	Kitchen	3,500	1	Tube axial Fan
2.0	First Floor			
	Toilets	5,000	1	Ceiling suspended Ducted Cabinet Fan
	Electrical Room	3,500	1	Tube axial Fan
3.0	Second Floor			
	Toilets	5,000	1	Ceiling suspended Ducted Cabinet Fan
	Small Toilets	700	2	Propeller Fan
	Electrical Room	3,500	1	Tube axial Fan
4.0	Third Floor			
	Toilets	5,000	1	Ceiling suspended Ducted Cabinet Fan
	Electrical Room	3,500	1	Tube axial Fan
5.0	Fourth Floor			
	Toilets	5,000	1	Ceiling suspended Ducted Cabinet Fan

		Electrical Room	3,500	1	Tube axial Fan
		Store Room	3,500	1	Tube axial Fan
	6.0	Fifth Floor			
		Toilets	5,000	1	Ceiling suspended Ducted Cabinet Fan
		Electrical Room	3,500	1	Tube axial Fan
		Tribal Museum			
	1.0	Ground to 2nd Floors			
		Toilets	2,400	5	Ceiling suspended Ducted Cabinet Fan
Notes:		Electrical Rooms & Maintenance Room	2,000	4	Tube axial Fan

- Capacity of Ventilation fans mentioned above are indicative & for reference only. Exact capacity & quantity of each fan shall be finalised based on detail load calculations during engineering stage, to be submitted by the Contractor, as per latest architectural drawings and equipment heat loads of respective area.
- Static pressure of exhaust air fans shall be calculated by the Contractor based on layout drawing & to be submitted for approval during engineering stage.
- Any additional area requiring ventilation as per architectural drawings during engineering stage, shall be considered without any price implications.

EQUIPMENT SPECIFICATION

TUBE AXIAL FAN

Tube axial fans (variable pitch type) shall be of mild steel construction conforming to IS: 2062 (Gr. A) and casing thickness shall be 3 mm thick (min), industrial type with motor directly coupled to the impeller. The impeller shall be statically and dynamically balanced. These fans shall be supplied complete with cast aluminum alloy impeller, steel casing, motor, supports for total unit and other related accessories as required for the system such as fan fixing connection piece, fan

fixing plates and supports etc. All fans shall be AMCA certified. Axial Fans used for smoke exhaust system, shall be AMCA certified & designed for 250ºC for 120 minutes.

AIR INTAKE GRILLES/LOUVERS

Air intake grilles/louvers shall be provided for supply air inlet at the lower level of respective doors. The grilles/louvers shall consist of parallel metallic blades suitable for door fittings. Design face velocity for louvers is 2-2.5 m/s.

COWL WITH BIRD SCREEN

Cowl with bird screen shall be provided for exhaust air fans. Bird screen of 10 sq.mm and minimum 16 G wire mesh shall be provided on the outer face. Gravity louver dampers shall be provided for all the exhaust fans.

DUCTWORK & INSULATION

DUCTWORK

All galvanized carbon steel ductwork shall conform to IS:655 / SMACNA as applicable & shall have minimum zinc deposition of 180 gm/sq.m or better as per IS:277. All duct seams shall be filled with bitumastic cold emulsion or equivalent vapor seal.

All duct supports shall be provided at centre preferably not exceeding 2.5 Meter. The duct supports shall consist of structural steel angles and if required flats and jointed by bolting. Whenever duct support angles are to be fixed with reinforced concrete roof/floor slab, the anchoring screw shall be connected with duct support angles by means of intermediate angle plates with bolted connection, so as to facilitate early erection and dismantling. All items of duct support including MS rods, MS angles, double angles, auxiliary or special steel members, hooks, dash fasteners and all other supporting material required shall be provided by the BIDDER.

Fire proof Canvas or equal flexible connection shall be provided at each connection between duct work and AHU so as to isolate vibration.

Splitters & dampers shall be provided for equipment/area isolation & for proportional volume control of air. The same shall be min 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside the duct in accessible position.

Suitable vanes shall be provided in the duct collar to have uniform & proper air distribution.

Coating shall be of approved colour to match interiors.

Selection and placing of diffusers, grilles etc. shall by the Contractor matching the lighting fitting and the décor of the respective area.

Ductwork shall be designed based on equal friction method to have an velocity as mentioned below:

Max. allowable air flow velocity in supply air ducts for Air conditioning m/sec	7.5
Max. allowable air flow velocity in return air ducts for Air conditioning, if any, m/sec	6
Max. air flow velocity in ducts for Ventilation, m/sec	10
Max. Friction, inch wg. / 100 ft duct length	0.1
Max. Outlet velocity at Grille/ Diffusers, m/sec- other area	2.5

INSULATION

Duct Thermal Insulation

Supply and return air sheet metal ducting shall be thermally insulated with Factory Pasted Al. Foil Faced Fire retardant 19 mm thick Closed Cell Nitrile Rubber Insulation (UL/FM approved) with necessary Adhesive as recommended by the Manufacturer.

Duct Acoustic Insulation

The supply air ducting from the outlet of each AHU up to 6 meters will be acoustically insulated from inside with 10mm thick Open Cell Nitrile Rubber insulation on the ducts after applying two coats of cold setting adhesive (CPR X compound), to maintain noise level as mentioned.

The insulating material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.

Roof Insulation

Under deck insulation shall be provided by the Contractor for the exposed roof for air-conditioned spaces.

DAMPERS, GRILLS, DIFFUSERS

All ducted indoor units shall have motorised fire damper as per UL 555 for 90 minutes rating for supply/ return duct (as applicable). Fire dampers shall be provided wherever duct crosses any

wall / roof to isolate the respective AC unit in the event of fire. The space around the ducts and refrigerant / drain pipes shall be sealed with fire retardant material.

All supply air grills / diffusers of air-conditioned areas shall be provided with volume control dampers.

The grills / diffusers will be of extruded aluminium powder coated.

PREFFERED MAKE LIST

Sr. No.	Description	Make
1	VRF System	Blue Star / Daikin / Mitsubishi / Toshiba / Voltas / LG / Samsung
2	Air Filters	Clean filter /FMI / Spectrum
3	Fan / Blower	Kruger / Nicotra / Systemair / Greenheck / Comefri
4	GI Duct Sheet	Jindal / SAIL / Tata Steel
5	Grilles / Diffusers / Fire Damper / VCD	Air Master / Dynacraft / TSC/ Systemair / Carryaire
6	Refrigerant copper Piping	Nippon / Nissan / Rajco
7	Insulation	
	EPS	Beard sell / Lloyd
	Nitrile Rubber	Aeroflex / Armaflex / Kflex / Armacell

Note:

Bidder to take written approval from Purchaser / Consultant regarding make of items other than as listed above.

EQUIPMENT DATA SHEETS

VRF UNIT

SL. NO.	ITEM	UNIT	
1.0	GENERAL		
1.1	DESIGNATION		VRF SYSTEM FOR
1.2	MAKE AND MODEL NUMBER		
1.3	NUMBER OFFERED	(W+S)	
1.4	TAG NUMBERS		
1.5	COOLING CAPACITY	(BTU/Hr)	
1.6	POWER INPUT AT COOLING CAPACITY	KW	
1.7	CONDENSING TEMPERATURE AND PRESSURE	Deg.C and bar	
1.8	TEMPERATURE OF LIQUID REFRIGERANT AT THE OUTLET OF SUB-COOLER	Deg.C	
1.9	PLACE OF MANUFACTURE		
1.10	CAPACITY OF EACH VRF SYSTEM AT DESIGNCONDITIONS	TR	
1.11	REFRIGERANT		R407C / R410A
1.12	EACH VRF UNIT SIZE (L ×W× H) AND NUMBER OF UNITS	Mm	
1.13	CLEARNACE REQUIRED		
1.13.1	FRONT	Mm	
1.13.2	BACK	Mm	
1.13.3	SIDE	Mm	
1.13.4	TOP	Mm	
1.14	DRY WEIGHT	Kg	
1.15	OPERATING WEIGHT	Kg	
1.16	NOISE LEVEL AT 1.5 m DISTANCE		

SL. NO.	ITEM	UNIT	
1.16.1	OUTDOOR UNIT	dBA	
1.17	NUMBER OF REFRIGERATION CIRCUITS	Nos.	
1.18	TOTAL INPUT POWER AT DESIGN CONDITIONS/VOLTAGE	kW/V	
2.0	COMPRESSOR		
2.1	TYPE		HERMETIC/ SEMI-HERMETIC/SCROLL
2.2	NUMBER OF COMPRESSORS	Nos.	
2.3	MAKE AND MODEL NUMBER		
2.4	PLACE OF MANUFACTURE		
2.5	SUCTION TEMPERATURE	OC	
2.6	SUCTION PRESSURE	kg/cm2(g)	
2.7	CONDENSING TEMPERATURE	OC	
2.8	CONDENSING PRESSURE	kg/cm2(g)	
2.9	OPERATNG SPEED	RPM	
2.10	INPUT POWER AT DESIGN CONDITION	KW	
2.11	MOTOR RATING	KW	
2.12	CAPACITY CONTROL AVAILABLE		YES / NO
2.13	IN STEPS OF IF YES		
3.0	BLOWER SECTION		
3.1	FAN		
3.1.1	NUMBER OF FANS		
3.1.2	MAKE AND MODEL NUMBER		
3.1.3	CAPACITY OF EACH FAN	m3/hr	
3.1.4	STATIC PRESSURE	mm WC	
3.1.5	STATIC PRESSURE EXTERNAL TO THE PAC	mm WC	
3.1.6	DISCHARGE DIRECTION		HORIZONTAL/VERTICAL UP/DOWN

SL. NO.	ITEM	UNIT	
3.1.7	IMPELLER SPEED	RPM	
3.1.8	OUTLET VELOCITY	m/s	
3.1.9	IMPELLER MATERIAL		
3.1.10	BRAKE POWER	kW	
3.1.11	POWER INPUT TO MOTOR AT DUTY POINT	kW	
3.1.12	MOTOR RATING	kW	
3.1.13	MOTOR MAKE		
3.2	DX COOLING COIL		
3.2.1	NUMBER OF COOLING COILS	Nos.	
3.2.2	SENSIBLE COOLING CAPACITY AT DESIGN CONDITIONS	kCal/hr	
3.2.3	LATENT COOLING CAPACITY AT DESIGN CONDITIONS	kCal/hr	
3.2.4	FACE AREA	m2	
3.2.5	TUBE OUTSIDE DIAMETER AND THICKNESS	mm	
3.2.6	NUMBER OF ROWS DEEP	Nos.	
3.2.7	NUMBER OF FINS PER CENTIMETER	Nos.	
3.2.8	AIR FACE VELOCITY	m/s	
3.2.9	AIR SIDE PRESSURE DROP	mm WC	
3.3	FILTERS		
3.3.1	NUMBER OF FILTERS		
3.3.2	MAKE AND MODEL NUMBER		
3.3.3	FILTER MATERIAL		
3.3.4	OVERALL SIZE OF EACH FILTER- L×W	mm	
3.3.5	AIR SIDE PRESSURE DROP AT RATED CAPACITY	mm WC	
3.3.6	EFFICIENCY OF FILTER		
4.0	CONDENSER		
4.3.1	NUMBER OF CONDENSERS		
4.3.2	MAKE AND MODEL NUMBER		

SL. NO.	ITEM	UNIT	
4.3.3	HEAT REJECTION CAPACITY AT DESIGNCONDITIONS	kCal/hr.	
4.3.4	OVERALL SIZE OF FAN AND COIL UNIT OF EACH CONDENSER: L ×W×H	mm	
4.3.5	MAXIMUM PERMISSIBLE DISTANCE BETWEEN CONDENSER AND INSIDE UNIT (VERTICAL & TOTAL)	m	
4.3.6	CONDENSER FANS		
a)	NUMBERS IN EACH CONDENSER	Nos.	
b)	CAPACITY OF EACH FAN	m3/hr.	
c)	STATIC PRESSURE	mm WC	
d)	IMPELLER MATERIAL		
e)	BRAKE POWER OF EACH FAN	kW	
f)	INPUT POWER OF EACH FAN	kW	
g)	MOTOR RATING OF EACH FAN	kW	
5.0	ACCESSORIES		
5.1	TYPE OF VIBRATION ISOLATORS		
5.2	REMOTE CONTROLLER		
5.3	FUNCTIONS		
5.4	FILTER MAINTENANCE TIME		
5.5	FAULT CODE DISPLY		
5.6	FACILITY TO CONNECT TO A SECOND (SUB) CONTROLLER		
6.0	MAKES		
6.1	THERMOSTATIC EXPANSION VALVE		
6.2	HIGH AND LOW PRESSURE CUT OUTS		
6.3	THERMOSTAT		
6.4	HUMIDISTAT		
7.0	PERFORMANCE GUARANTEE		
7.1	CAPACITY AT DESIGN CONDITIONS	TR	

SL. NO.	ITEM	UNIT	
7.2	TOTAL POWER INPUT AT DESIGN CONDITIONS	kW	
7.3	BLOWER		
7.4	STATIC PRESSURE EXTERNAL	mm WC	
7.5	DEHUMIDIFIED AIR FLOW CAPACITY AT SPECIFIED EXTERNAL STATIC PRESSURE	m3/hr.	
7.6	NOISE LEVEL AT 1.5m DISTANCE FROM		
7.6.1	VRF OUTDOOR UNIT	dBA	

AXIAL FLOW FAN

	DATASHEET A		
1.0	**GENERAL**		
1.1	DESIGNATION		AXIAL FANS FOR SUPPLY / EXHAUST
1.2	NUMBER REQUIRED		*
1.3	TAG NUMBERS		*
1.4	LOCATION		INDOOR / ROOF TOP
1.5	DUTY		CONTINUOUS
1.6	LOCATION IN HAZARDOUS AREA		*
1.7	HAZARDOUS AREA CLASSIFICATION		*
2.0	**DESIGN DATA**		
2.1	CAPACITY AT SUCTION CONDITIONS		

	DATASHEET A		
2.1.1	NORMAL	M^3/Hr	*
2.1.2	MINIMUM	M^3/Hr	*
2.1.3	MAXIMUM	M^3/Hr	*
2.2	GAS HANDLED		AIR
2.3	GAS CONDITION AT SUCTION		
2.3.1	TEMPERATURE		*
2.3.2	RELATIVE HUMIDITY		AMBIENT
2.3.3	DENSITY	kg/M^3	
2.4	STATIC PRESSURE	mmWC	
2.5	MAXIMUM FAN SPEED		
2.5.1	FOR IMPELLER DIAMETER 450 mm AND LESS		1500 RPM
2.5.2	FOR IMPELLER DIAMETER ABOVE 450 mm		1000 RPM
2.6	DESIGN AMBIENT TEMPERATURE		
2.7	ELEVATION ABOVE MEAN SEA LEVEL	M	
3.0	**CONSTRUCTION FEATURES**		
3.1	TYPE		TUBE AXIAL / PROPELLER
3.2	SPARK PROOF CONSTRUCTION TYPE		AS PER AMCA A / B / C
3.3	DRIVE		DIRECT

	DATASHEET A		
3.4	ADJUSTABLE PITCH BLADES REQUIRED		NO
3.5	TYPE OF MOUNTING		WALL / IN DUCT
3.6	PAINTING		AS PER IS STANDARD
4.0	**MATERIAL OF CONSTRUCTION**		
4.1	CASING		CS
4.2	IMPELLER		CAST AL
4.3	SHAFT		EN 8
4.4	INLET CONE OR BELL		MS
4.5	OUTLET CONE		MS
4.6	GUIDE VANE		*
5.0	**ACCESSORIES**		
5.1	FLEXIBLE CONNECTION AT FAN OUTLET		FOR TUBE AXIAL FAN - YES
5.2	SOLATION DAMPERS AT FAN INLET /		YES
5.3	INLET CONE OR BELL AND OUTLET CONE		FOR SUPPLY AIR FAN YES
5.4	LOUVERED SHUTTERS		FOR EF YES
5.5	WALL COWL WITH BIRD SCREEN		FOR SUPPLY AIR FAN YES
5.6	FLEXIBLE COUPLING AND COUPLING GUARD		NO
5.7	WOODEN BLOCK FOR MOUNTING		NO

	DATASHEET A		
5.8	COMMON BASE FRAME OR SUPPORTING FRAME FOR MOUNTING		YES
5.9	NEOPRENE RUBBER PADS		YES
5.10	FOUNDATION BOLTS		YES
5.11	VIBRATION ISOLATORS		YES
5.12	RIBBED NEOPRENE RUBBER PADS BETWEEN FOUNDATION BLOCK AND FLOOR FOR FLOOR MOUNTED FANS		NO
6.0	**MOTOR DATA**		
6.1	MOTOR BY		*
6.2	STARTER BY		*
7.0	**TESTING & INSPECTION**		
7.1	TESTING & INSPECTION		AS PER IS STANDARD

	DATASHEET B		
	GENERAL		
1.1	DESIGNATION		AXIAL / PROPELLER FANS FOR
1.2	NUMBER REQUIRED		
1.3	TAG NUMBERS		
1.4	LOCATION		
1.5	DUTY		
	DESIGN DATA		

	DATASHEET B		
2.1	CAPACITY AT SUCTION CONDITIONS		
2.1.1	NORMAL	M^3/Hr	
2.1.2	MINIMUM	M^3/Hr	
2.1.3	MAXIMUM	M^3/Hr	*
2.2	GAS HANDLED		AIR
2.3	GAS CONDITION AT SUCTION		
2.3.4	TEMPERATURE		
2.3.5	RELATIVE HUMIDITY		
2.3.6	DENSITY	kg/m^3	
2.4	STATIC PRESSURE	mmWC	
2.5	MAXIMUM FAN SPEED		
2.5.3	FOR IMPELLER DIAMETER 450 mm AND LESS		
2.5.4	FOR IMPELLER DIAMETER ABOVE 450 mm		
2.6	DESIGN AMBIENT TEMPERATURE		
2.7	ELEVATION ABOVE MEAN SEA LEVEL	M	
	CONSTRUCTION FEATURES		
3.1	TYPE		
3.2	SPARK PROOF CONSTRUCTION TYPE		
3.3	DRIVE		

	DATASHEET B		
3.4	ADJUSTABLE PITCH BLADES REQUIRED		
3.5	TYPE OF MOUNTING		
3.6	PAINTING		
	MATERIAL OF CONSTRUCTION		
4.1	CASING		
4.2	IMPELLER		
4.3	SHAFT		
4.4	INLET CONE OR BELL		
4.5	OUTLET CONE		
4.6	GUIDE VANE		
	ACCESSORIES		
5.1	FLEXIBLE CONNECTION AT FAN OUTLET		FOR TUBE AXIAL FAN - YES
5.2	SOLATION DAMPERS AT FAN INLET /		YES
5.3	INLET CONE OR BELL AND OUTLET CONE		FOR SUPPLY AIR FAN YES
5.4	LOUVERED SHUTTERS		FOR EXHAUST YES
5.5	WALL COWL WITH BIRD SCREEN		FOR SUPPLY AIR FAN YES
5.6	COMMON BASE FRAME OR SUPPORTING FRAME FOR MOUNTING		YES
5.7	NEOPRENE RUBBER PADS		YES

	DATASHEET B		
5.8	FOUNDATION BOLTS		YES
5.9	VIBRATION ISOLATORS		YES
5.10	RIBBED NEOPRENE RUBBER PADS BETWEEN FOUNDATION BLOCK AND FLOOR FOR FLOOR MOUNTED FANS		NO
	ELECTRICAL		
6.1	MOTOR BY		
6.2	STARTER BY		
6.3	POWER REQUIREMENT		
6.3.1	POWER INPUT TO FAN AT DUTY POINT (BKW)	kW	
6.3.2	MAXIMUM POWER REQUIREMENT AT SELECTED SPEED	kW	
6.3.3	MOTOR RATING	kW	
6.3.4	POWER INPUT TO MOTOR AT DUTY POINT	kW	
	DOCUMENTS TO BE ENCLOSED		WHETHER ENCLOSED
7.1	GENERAL ARRANGEMENT DRAWING WITH MAJOR DIMENSIOND		YES / NO
7.2	PART LIST WITH CODES AND MATERIALS OF CONSTRUCTION		YES / NO
7.3	RATING CHARTS OR TABLES WITH SELECTION MARKED		YES / NO
7.4	PERFORMANCE CURVE WITH DUTY POINT MARKED		YES / NO

	DATASHEET B		
	PERFORMANCE GRARANTEES		
8.1	CAPACITY AT SUCTION CONDITIONS	M^3 /Hr	
8.2	STATIC PRESSURE	mmWC	
8.3	POWER CONSUMPTION	kW	

AIR DISTRIBUTION SYSTEM

	DATASHEET A		
1.0	**GENERAL**		
1.1	DESIGNATION		AIR DISTRIBUTION SYSTEM
2.0	**DUCTING**		
2.1	RECTANGULAR DUCTING		YES
2.2	MATERIAL		GSS
2.3	QUANTITY		
	DUCT GAUGE		
	24 G	SQ.M	
	22 G	SQ.M	
	20 G	SQ.M	
	18 G	SQ.M	
3.0	**DIFFUSERS**		
3.1	DIFFUSERS WITH VOLUME CONTROL DAMPER		YES
3.1.1	TYPE		SQUARE
3.1.2	PATTERN		FLUSH

	DATASHEET A		
3.1.3	MATERIAL		AL WITH POWDER COATING
3.1.4	QUANTITY		
	TYPE	NOS	SIZE, mm
	RECTANGULAR/SQUARE		
	RECTANGULAR/SQUARE		
i)	SQUARE DIFFUSERS	SQ.M	
ii)	SLOT DIFFUSER	SQ.M	
3.2	DIFFUSERS WITHOUT VOLUME CONTROL DAMPER		FOR RETURN AIR
3.2.1	TYPE		SQUARE (S)
3.2.2	PATTERN		FLUSH
3.2.3	MATERIAL		AL WITH POWDER COATING SS 304
3.2.4	QUANTITY		
	TYPE	NOS	SIZE, mm
	RECTANGULAR/SQUARE		
	RECTANGULAR/SQUARE		
i)	ROUND DIFFUSERS	SQ.M	
ii)	SQUARE DIFFUSERS	SQ.M	
iii)	LINEAR DIFFUSERS	SQ.M	
iv)	SLOT DIFFUSERS	SQ.M	
4.0	**GRILLES**		
4.1	GRILLES WITH VOLUME CONTROL DAMPER		

	DATASHEET A		
4.1.1	TYPE		DOUBLE ACTING
4.1.2	MATERIAL		CS WITH RUST RESIST. PRIMER/AL WITH POWDER COATING
4.1.3	QUANTITY	M^2	
4.2	GRILLES WITHOUT VOLUME CONTROL DAMPER		
4.2.1	TYPE		FIXED BLADE / ADJUSTABLE BLADE
4.2.2	MATERIAL		CS WITH RUST RESIST. PRIMER/AL
4.2.3	QUANTITY	M^2	
5.0	**DAMPERS**		
5.1	OPPOSED BLADE TYPE VOLUME CONTROL DAMPER FOR RECTANGULAR DUCT WITH BRASS BUSHING	M^2	
5.2	MOTORIZED DAMPER		YES
5.2.1	SHAFT BLADE TO BE PROVIDED WITH		BRASS BUSHING / TEFLON BUSHING / SEALED BALL BEARING
5.2.2	FOR RECTANGULAR DUCT	M^2	
5.3	FIRE DAMPERS		YES
5.3.1	TYPE		MOTORISED
5.3.2	QUANTITY	QTY	
6.0	**INSULATION**		

	DATASHEET A		
6.1	ACOUSTIC INSULATION		YES
6.1.1	MATERIAL		REF. TECHNICAL SPECIFICATION
6.1.2	DENSITY	kg/M^3	
6.1.3	THICKNESS	mm	REF. TECHNICAL SPECIFICATION
6.1.4	QUANTITY	M^2	
6.2	THERMAL INSULATION		YES
6.3	COMPANION SPECIFICATION		REF. TECHNICAL SPECIFICATION
7.0	**MISCELLANEOUS**		
7.1	PLENUM		YES
7.2	QUANTITY		AS PER AC LAYOUT
7.3	ACCESS DOORS TO BE PROVIDED		YES
7.4	FLEXIBLE CONNECTION OTHER THAN AT EQUIPMENT INLET AND OUTLET	M^2	
7.5	FRAME WORK FOR, GRILLES, WALL MOUNTED VCD AND FIRE DAMPERS		CS / SS BY BIDDER
7.6	DUCT SUPPORTS QUALIFIED FOR SEISMIC FORCES		YES
8.0	**TESTING & INSPECTION**		
8.1	TESTING & INSPECTION		AS PER IS STANDARD

	DATASHEET B		
1.0	**GENERAL**		
1.1	DESIGNATION		AIR DISTRIBUTION SYSTEM FOR
2.0	**DUCTING**		
2.1	TYPE		RECTANGULAR
2.2	MATERIAL		GSS / AL / SS 304
2.3	TYPE		ROUND
	MATERIAL		GSS / AL / SS 304
	SEAM		SPIRAL / LONGITUDINAL
3.0	**DIFFUSERS**		
3.1	DIFFUSER WITH VOLUME CONTROL DAMPER		YES / NO
3.1.5	TYPE		ROUND / SQUARE / LINEAR / SLOT
3.1.6	PATTERN		FLUSH / STEPPED
3.1.7	MATERIAL		CS WITH RUST RESISTANT PRIMER / AL WITH POWDER COATED / SS 304
3.2	DIFFUSER WITHOUT VOLUME CONTROL DAMPER		YES / NO
3.2.1	TYPE		ROUND / SQUARE / LINEAR / SLOT
3.2.2	PATTERN		FLUSH / STEPPED
3.2.3	MATERIAL		CS WITH RUST RESISTANT PRIMER / AL WITH POWDER COATED / SS 304
4.0	**GRILLES**		

	DATASHEET B		
4.1	GRILLES WITH VOLUME CONTROL DAMPER		YES / NO
4.1.4	TYPE		SINGLE ACTING / DOUBLE ACTING
4.1.5	MATERIAL		CS WITH RUST RESIST. PRIMER / AL WITH POWDER COATING / SS304
4.1.6	QUANTITY	M^2	
4.2	GRILLES WITHOUT VOLUME CONTROL DAMPER		
4.2.4	TYPE		FIXED BLADE / ADJUSTABLE BLADE
4.2.5	MATERIAL		CS WITH RUST RESIST. PRIMER/AL
4.2.6	QUANTITY	M^2	
5.0	**DAMPERS**		
5.1	OPPOSED BLADE TYPE VOLUME CONTROL DAMPER FOR RECTANGULAR DUCT WITH BRASS BUSHING	M^2	YES / NO
5.2	MOTORIZED DAMPER		YES / NO
5.2.3	SHAFT BLADE TO BE PROVIDED WITH		BRASS BUSHING / TEFLON BUSHING / SEALED BALL BEARING
5.2.4	FOR RECTANGULAR DUCT	M^2	
5.3	FIRE DAMPERS		YES / NO
5.3.3	TYPE		MOTORISED

	DATASHEET B		
6.0	**INSULATION**		
6.1	ACOUSTIC INSULATION		YES / NO
6.1.5	MATERIAL		
6.1.6	DENSITY	kg/M^3	
6.1.7	THICKNESS	mm	
6.1.8	QUANTITY	M^2	
6.2	THERMAL INSULATION		YES / NO
6.3	MATERIAL		REF. TECHNICAL SPECIFICATION
6.4	DENSITY	kg/M^3	
6.5	THICKNESS	mm	
6.6	THERMAL CONDUCTIVITY	Kcal / hr m deg C	
7.0	**MISCELLANEOUS**		
7.1	PLENUM		YES / NO
7.2	ACCESS DOORS		YES / NO
7.3	FLEXIBLE CONNECTION OTHER THAN AT EQUIPMENT INLET AND OUTLET	M^2	YES / NO
7.4	FRAME WORK FOR, GRILLES, WALL MOUNTED VCD AND FIRE DAMPERS		CS / SS
7.5	DUCT SUPPORTS QUALIFIED FOR SEISMIC FORCES		YES / NO
7.6	PAINTING		YES / NO

	DATASHEET B		
7.7	DUCTS		UNPAINTED /EPOXY / SYNTHETIC ENAMEL
7.8.1	DUCT SUPPORTS		RED OXIDE PRIMER / EPOXY / SYNTHETIC ENAMEL
7.8.2	DIFFUSERS IN CASE OF CS		UNPAINTED / EPOXY
7.8.3	GRILLES IN CASE OF CS		UNPAINTED / EPOXY

INSULATION

	DATASHEET A		
1.0	**GENERAL**		
1.1	PIPES : REFRIGNERANT SUCTION AND LIQUID LINES		REF. TECHNICAL SPECIFICATION
1.2	AIR-CONDITIONING SYSTEMS ENTIRE SUPPLY AND RETURN AIR DUCT		REF. TECHNICAL SPECIFICATION
1.3	INSULATION ADHESIVE		CPR X COMPOUND
1.4	FINISHING		AS PER IS STANDARD

	DATASHEET B		
1.0	**GENERAL**		
1.1	INSULATION MATERIALS		
1.1.1	EQUIPMENT		
1.1.2	PIPING SYSTEMS		
1.1.3	AIR-CONDITIONING DUCT		
1.2	INSULATION ADHESIVES		

	DATASHEET B		
1.3	VAPOUR BARRIERS		
1.4	FINISHING MATERIALS		
1.4.1	EQUIPMENT		
1.4.2	PIPING SYSTEMS		
1.4.3	AIR-CONDITIONING DUCT		
1.5	DENSITY OF EACH OF THE INSULATING MATERIALS	kg/M^3	
1.6	IS ANY INSULATION MATERIAL CORROSIVE TO CARBON STEEL OR ALLOY STEEL SURFACE IN CONTACT		YES / NO
1.7	INSULATION THICKNESSES FOR ALL INSULATION MATERIALS SELECTED, IN THE FORMAT SIMILAR TO THAT IN DATA SHEET A, TO BE ENCLOSED.		WHETHER ENCLOSED YES / NO

FILTER

	DATASHEET A		
1.0	**GENERAL**		
1.1	DESIGNATION		*
1.2	SERVICE		AMBIENT AIR FOR AC SYSTM / /VENTILATION SYSTEM
1.3	APPLICATION		*
1.4	TYPE		CASSETTE / FLANGE

	DATASHEET A		
1.5	CLEANING METHOD		CLEANABLE
2.0	**DESIGN DATA**		
2.1	TOTAL AIR FLOW RATE		*
2.2	TEMPERATURE OF AIR	°C	*
2.3	RELATIVE HUMIDITY	%	*
2.4	DUST LOADING	gm/M^3	*
2.5	EFFICIENCY		90% DOWN TO 10 MICRONS
2.6	TYPE OF CONTAMINATION		RADIO ACTIVE / CORROSIVE
2.7	MAXIMUM FILTER FACE VELOCITY	M/sec	2.5 FOR PRE FILTER 1.8 FOR FINE FILTER (FOR 150 MM) 2.4 FOR FINE FILTER (FOR 300 MM)
2.8	TOTAL FACE AREA OF FILTERS REQUIRED		*
2.9	FILTER MEDIA		SYNTHETIC FIBRE / HDPE / GLASS FIBRE PAPER
2.10	LIFE OF FILTER MEDIA FOR THROW AWAY	Hrs	*
2.11	PREFERRED SIZE OF EACH FILTER PANEL :		610 mm x 610 mm x 50 mm THK
2.12	NUMBER OF FILTER PANELS		*
2.13	WEIGHT OF EACH FILTER	kg	

	DATASHEET A		
2.14	MAXIMUM ALLOWABLE PRESSURE DROP FOR DESIGN FLOW RATE IN		
2.14.1	CLEAN CONDITION	mmWC	*
2.14.2	CLOGGED CONDITION	mmWC	*
3.0	**MATERIAL OF CONSTRUCTION**		
3.1	MOUNTING FRAME / SUPPORTING FRAME WORK FOR FILTER ASSEMBLY		GSS/ HOT DIP GALVANISED
3.2	GASKETS FOR FILTER ASSEMBLY		NEOPRENE RUBBER
3.3	FASTENERS		GS / SS
4.0	**TESTING & INSPECTION**		
4.1	TESTING AT WORKS		EFFICIENCY AND PRESSURE DROP FOR ALL FILTERS
4.2	TESTING AT SITE		EFFICIENCY AND PRESSURE DROP, LEAKAGE AND FILTER BANK LEAKAGE

	DATASHEET B		
1.0	**GENERAL**		
1.1	DESIGNATION		
1.2	APPLICATION		PRE / FINE

	DATASHEET B		
1.3	TYPE		CASSETTE/FLANGE
1.4	MANUFACTURER		
1.5	MODEL NUMBER		
1.6	WHETHER CLEANABLE		YES / NO
1.7	CLEANING METHOD		
1.7.1	REMOVAL AND CLEANING IN REMOTE PLACE BY AIR JET / WATER		YES / NO
1.7.1.1	AIR/WATER PRESSURE REQUIRED	kg/cm^2g	
1.7.2	MECHANICAL CLEANING IN-SITE (WITHOUT REMOVING FILTERS) BY REVERSE COMPRESSED AIR JET		YES / NO
1.7.2.1	AIR PRESSURE REQUIRED	kg/cm^2g	
1.8	FILTER MEDIA		SYNTHETIC FIBRE / HDPE /
			GLASS FIBRE PAPER
1.9	LIFE OF FILTER MEDIA FOR THROW AWAY TYPE	Hrs	
1.10	DUST LOADING CAPACITY	gms	PER FILTER
2.0	**DESIGN DATA**		
2.1	TOTAL FACE AREA OF FILTERS	M^2	
2.2	NUMBER OF FILTERS		
2.3	SIZE OF EACH FILTER L x B x THK	mm	x
2.4	DESIGN AIR FLOW RATE PER FILTER	M^3/Hr	
2.5	WEIGHT OF EACH FILTER	kg	

	DATASHEET B		
2.6	PRESSURE DROP AT DESIGN FLOW RATE IN		
2.6.1	CLEAN CONDITION	mmWC	
2.6.2	CLOGGED CONDITION	mmWC	
2.7	EFFICIENCY	%	DOWN TO MICRONS
3.0	**MATERIAL OF CONSTRUCTION**		
3.1	FILTER PANEL FRAME		
3.2	MOUNTING FRAME / SUPPORTING FRAME WORK FOR FILTER ASSEMBLY		
3.3	GASKETS FOR FILTER ASSEMBLY		
3.4	FASTENERS		
4.0	**MISCELLANEOUS**		
4.1	TYPE AND METHOD OF TESTS AS SPECIFIED ARE ACCEPTABLE		YES / NO
4.2	WHETHER FILTER IS COMPATIBLE WITH THE TYPE OF CONTAMINATION		YES / NO
4.3	SELECTION CHARTS WITH DUTY POINT MARKED FOR CLEAN AND CLOGGED FILTER CONDITION TO BE ENCLOSED		WHETHER ENCLOSED YES / NO

DATA TO BE FURNISHED ALONG WITH THE BID

GENERAL

- Write-up on technical features of equipment offered.
- Filled-in Data Sheet as called for in the Technical Specification.

- Actual user's performance certificates in respect of equipment of systems covered under contract.
- Name of manufacturers of all major mechanical equipment.
- Operation & maintenance requirements for next five (05) years.
- List of recommended spare parts with price list.
- Bar Chart/PERT Network schedule incorporating the following major activities
- Design and Engineering
- Supply of equipment and accessories
- Erection schedule
- Testing and commissioning schedule

MECHANICAL

Offer shall be submitted as per enquiry specification.

- Duly filled-in and stamped Data Sheets for all HVAC equipment.
- VRF selection with product catalogue.
- Confirmation of outdoor unit location & space provided.
- Equipment Selection and schedule with model no. make and Motor List.
- List of deviations if any.
- Experience list for similar type of equipment supplied, which should indicate the name of customer, date of ordering, date of commissioning.

DATA TO BE FURNISHED AFTER AWARD OF CONTRACT

Successful Bidder to submit following document after award of contract for approval of Purchaser:

a. List of drawings/documents to be submitted for review, approval and information with scheduled submission dates.
b. Detail Heat Load Calculations for Air conditioning & Ventilation systems.
c. Air-conditioning Layout drawings of each floor.
d. Ventilation Layout drawings of each floor / area.
e. Air-conditioning schematic layout.
f. Refrigerant piping layout drawings for each VRF system.
g. CFD Analysis along with jet fan & CO sensor locations for basement car parking areas.
h. GA drawings, Data Sheets of each equipment.
i. Equipment Schedule with Electrical Load List.
j. Vibration isolator selection, inertia block selection, sound attenuator selection, equipment sound power level and sound pressure level data.

k. Quality Assurance Plan (QAP)
l. PG test procedure.
m. Internal inspection documents/test reports of equipment before despatch clearance.
n. Billing schedule.

In addition to this, Bidder shall provide sample for the following items along with catalogue and sample approval must be taken before procurement of items:

a. Grilles, Diffusers.
b. Volume control dampers.
c. Fire dampers.
d. Thermal insulation for ducts as well as refrigerant pipes.

OPERATION AND MAINTENANCE

The Contractor shall be required to operate and maintain the system designed, supplied, installed, tested and commissioned by him, for the duration of Five years. The Operation and Maintenance Contract shall be comprehensive type. The Contractor shall take full responsibility for the care of the mechanical services/ system and other allied systems during the contract period till it is handed over to the employer at the end of 5 years of O&M.

If any loss or damage occurs to the treatment works or to any other system, during the period for the contractor is responsible, the contractor shall rectify such loss or damage, at his cost, so that all the mechanical services/ system conforms to its condition when the contractor took possession of the treatment works at the commencement of the contract.

The Contractor shall be responsible for, but not limited to, the following:

- Providing the required staff, but not less than the minimum specified numbers/ level, during operation and maintenance period and additional staff as per requirement during periodic maintenance and in emergencies.
- Providing all required consumables such as spares, tools, tackles & equipment and consumables required for functioning of equipment.
- Establish work control procedures including preventive and corrective maintenance so that the entire mechanical services/ system shall work in automatic mode and/or semiautomatic at all times.
- Submission of monthly report.
- The Contractor shall be solely responsible for the safety and security of the goods in the store and will be responsible for any loss or damages in stores for any reason.
- Proper maintenance and housekeeping along with provision of all tools & equipment.

- Insurance: The Contractor shall, without limiting his or the Employer's obligations and responsibilities undertake the following;
- The insurance shall be at the Contractor's cost and shall cover the Employer and the Contractor against all losses or damages from whatsoever cause arising from the start of the O&M until the date of completion of O&M in respect of the facility or any section or part thereof as the case may be.
- Insurance shall cover for all the Civil, mechanical, electrical and instrumentation works together with material to the full replacement cost.
- Any amount not insured or not recovered from the insurer shall be borne by the Contractor.

Technical Specifications for ICT Works

1.1 FIRE DETECTION & ALARM SYSTEM (FDAS)

1.1.1 Fire Detection & Alarm System Components

The Fire Detection and Alarm system comprises of the following:

a) Addressable Multi Criteria detectors
b) Addressable Heat detectors
c) Flush Mount Detectors
d) Loop Powered Sounders cum strobe
e) Addressable Manual call points
f) Addressable Conventional Zone Module
g) Addressable Control module
h) Beam Detector
i) Aspiration Detector
j) FDAS panel
k) Cabling for FDAS
l) I/O Modules
m) Auto-Dialer
n) Telephone Jack/Handset

All detectors and Manual call points shall be identified with a point address.

1.1.2 Fire Alarm Control Panel

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	All the FACPs provided shall have the capacity to expand from 1 to 32 loops for Future expansion		
2	Each loop shall accommodate maximum 250 detectors and devices in any combination with a loop length capable up to 1.6 kms with 2C x 1.5 sq mm cable		

S. No	Technical Requirement	Compliance Yes/No	Remarks
3	FACP will function as fully stand-alone panel & also networked to other FACPs with peer to peer communication		
4	Each FACP shall have a possibility of accommodating redundant controller to takeover in case of a Failure in the Primary Controller and also redundant loop card for each loop to takeover in case of a Failure in the Primary Loop Card.		
5	Each FACP shall have inbuilt LCD color touch screen (320*240 pixels)to clearly indicate the location of fire, type of device activated other indications like service requirement of a component, etc.		
6	In case of a Loop Card Failure, the FACP shall allow to replace the Loop card without switching off the panel and reprogramming.		
7	The FACP shall be of seamless integrated with PA use of RS232 module FA & PA both system shall be of same make		
8	FACPs shall have inbuilt buzzer to alert the personnel in case of maintenance requirement		
9	ACP shall be programmed for sequence of events to happen in case of fire like closing of fire dampers, shutting down supply fans for HVAC, Deactivating the access control system and activating the hooters with the help of a control relay module provided near the system to be activated.		
10	All the fire alarm modules (loop cards, networking cards, and communication card. Etc.) Should be hot pluggable and hot swappable to facilitate easy replacement of faulty modules. All the electronic components		

S. No	Technical Requirement	Compliance Yes/No	Remarks
	shall be compatible to non-air-conditioned environment for working satisfactorily		
11	The FACP shall have an ingress protection of at least IP – 30		
12	It shall be capable of being surface, semi-flush or fully flush mounted with additional bezel. The fully flush bezels shall be painted to specification, stainless steel or brass as required.		
13	FACP shall mount in wall		
14	All the wiring shall be done using ferrules having indelible marking		
15	The FACP shall have a processor, which shall be of at-least 32 bit, which shall be designed to accept all the inputs and process the outputs within the time stipulated by the standards.		
16	A redundant CPU shall be provided with the same configuration which shall be made as hot standby – in case of failure of the main CPU, the standby shall takeover without interrupting the system		
17	The CPU shall have the facility to communicate with other FACPs and process the fire signals received from other FACPs to actuate a third party device		
18	capacity of the processor shall be adequately designed include all input / output signals and various functional requirements		
19	It shall have its own, built in advanced microprocessor, sophisticated software and extensive memory for storing the logs of alarms, times and action taken report.		

1.1.3 Loop Modules

S.No	Technical Requirement	Compliance Yes/No	Remarks
1	The loop module shall have a microprocessor inbuilt & shall be capable of handling 250 detectors and devices in any combination		
2	It shall have a line length up to 1600m or 3000m depending upon the configuration & cable type		
3	The loop module shall be encapsulated & shall be hot pluggable.		
4	In case of the failure of loop card, it should be replaced without the need of any additional programming.		

1.1.4 Intelligent Addressable Optical Smoke/ Heat (Multi-sensor) Detector

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	The Intelligent Addressable Multi-sensor Detector used in this Building shall confine to the relevant standards having the following features		
2	It shall be combination of Smoke detection and heat detection. The smoke detection system shall work on Light scattering type principle using Infrared and the Heat detection system shall be of Rate of rise of temperature and Fixed Temperature.		
3	The Intelligent Addressable Multi-sensor Detector shall be of Spot type and Addressable type		
4	The Intelligent Addressable Multi-sensor Detector shall be addressed either by DIP switches or through Programming from the Panel		

S. No	Technical Requirement	Compliance Yes/No	Remarks
5	The Detector shall monitor EMC/EMI values in the surroundings on a continuous basis and report the current & average values to the panel. The detector and the panel shall together avoid the possibility of false alarm caused due to interferences from sources such as Motors, power cables, Wi-Fi routers, fluorescent lamps, network switches, mobile signals…etc.		
6	All the detectors shall have a visible multi-color LED to indicate the healthiness / trouble / alarm condition of the detector. The LED shall be located in such a way that it shall be visible from all the 360 degree from below. In some cases where the visibility of the detector is obstructed by cable trays, false ceiling etc. Facility for connecting the detector to a response indicator has to be present. The response indicator derives the power to glow from the loop.		
7	It shall possess False alarm immunity and a superior signal to noise ratio		
8	It shall have a Built in signal processor		
9	It shall be with 2 inbuilt fault isolators.(Detectors without Inbuilt Isolators may be considered with separate Isolator Base)		
10	It shall have drift compensation facility built in.		
11	The detectors shall communicate the ambient reading to the FACP on time to time basis, and the FACP shall make the decision about the current status of the detector, whether it is in fire/pre-alarm/maintenance requirement etc.		
12	The detector shall have at least 15 levels of sensitivity settings based on the application and room where it is installed.		

S. No	Technical Requirement	Compliance Yes/No	Remarks
13	The detector shall provide a chambermaid plug to blow out the dust/dirt using a blower.		
14	In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming		
15	The detector shall be programmed to work as Optical only or Thermal only detectors. It shall a provision to switch off any component (optical or thermal) of the detector.		
16	The detector shall work with 2 different sensitivity settings at any point of time and the User shall have access to choose the desired settings without programming or Laptop/PC for configuration		
17	The detector shall be capable of detecting both smoldering fires and open fires and shall be UL/EN54 /VdS approved		

1.1.5 Intelligent Addressable Heat Detector

S. No	Technical Requirement	Compliance Yes/No	Remarks
	The Intelligent Addressable Heat Detector used in this Building shall confine to the relevant standards having the following features		
1	The Heat detection system shall be of Rate of rise of temperature and Fixed Temperature		
2	The Intelligent Addressable Heat Detector shall be of Spot type and Addressable type		
3	The Intelligent Addressable Heat Detector shall be addressed either by DIP switches or through Programming from the Panel		

S. No	Technical Requirement	Compliance Yes/No	Remarks
4	The Detector shall monitor EMC/EMI values in the surroundings on a continuous basis and report the current & average values to the panel. The detector and the panel shall together avoid the possibility of false alarm caused due to interferences from sources such as Motors, power cables, Wi-Fi routers, fluorescent lamps, network switches, mobile signals…etc.		
5	All the detectors shall have a visible multi-color LED to indicate the healthiness / trouble / alarm condition of the detector. The LED shall be located in such a way that it shall be visible from all the 360 degree from below. In some cases where the visibility of the detector is obstructed by cable trays, false ceiling etc. Facility for connecting the detector to a response indicator has to be present. The response indicator derives the power to glow from the loop.		
6	It shall possess False alarm immunity and a superior signal to noise ratio		
7	It shall have a Built in signal processor		
8	It shall be with 2 inbuilt fault isolators.(Detectors without Inbuilt Isolators may be considered with separate Isolator Base)		
9	It shall have drift compensation facility built in.		
10	The detectors shall communicate the ambient reading to the FACP on time to time basis, and the FACP shall make the decision about the current status of the detector, whether it is in fire/pre-alarm/maintenance requirement etc.		
11	The detectors shall communicate the ambient reading to the FACP on time to time basis, and the FACP shall make the decision about the		

S. No	Technical Requirement	Compliance Yes/No	Remarks
	current status of the detector, whether it is in fire/pre-alarm/maintenance requirement etc		
12	In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming		
13	The detector shall work with 2 different sensitivity settings at any point of time and the User shall have access to choose the desired settings without programming or Laptop/PC for configuration		
14	The detector shall be capable of detecting both smoldering fires and open fires and shall be UL/EN54 /VdS approved		

1.1.6 Manual Call Point

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	Manual call points shall be of Double action - break glass type with Push Button.		
2	The mounted arrangement shall be such that it can be either surface mounted or flush mounted		
3	Each addressable MCP will comprise of an electronic circuit built into it to provide addressing capability		
4	The MCPs shall be provided with 2 inbuilt fault isolator. (the bidder shall consider a external isolator if not inbuilt)		
5	The MCP shall have a LED to indicate Alarms		
6	The MCP shall be UL/EN54/VdS approved		

1.1.7 Addressable Control Relay Module

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	The CRM shall provide a dry potential contact o/p for activating a variety of auxiliary devices and other fire fighting / ventilation equipment.		
2	It shall have a capability of handling at least 1A @ 30VDC to integrate with third party system.		
3	The CRM shall be addressable either by Dip switch or by the Panel		
4	The CRM shall be provided with 2 inbuilt fault isolator. (the bidder shall consider a external isolator if not inbuilt)		
5	The CRM shall be loop powered and shall be UL/EN54/VdS approved.		

1.1.8 Monitor Module

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	The MM shall provide 2 inputs and these inputs shall work independently to monitor 3rd party devices and shall allow to program with different parameters		
2	The MM shall have 2 inbuilt fault isolator module.(bidder shall consider external isolators if not inbuilt)		
3	The MM shall be programmed to monitor contacts, Voltage and EOL resistor as per site applications		
4	The MM when programmed to monitor contacts shall also allow to program to monitor either open/close contacts		

S. No	Technical Requirement	Compliance Yes/No	Remarks
5	The MM shall be addressable either by Dip switch or by the Panel		
6	The MM shall be loop powered and shall be UL/EN54/VdS approved.		

1.1.9 Addressable Loop Powered Sounder

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	The Sounder shall be an Addressable loop powered sounder. (Bidder shall consider external power supply, cable, conduits, modules required for activating externally powered sounders and include the costing as part of the item – Sounders)		
2	The Sounder shall have 2 inbuilt fault isolator module.(bidder shall consider external isolators if not inbuilt)		
3	The Sounder shall either be addressed by Dip switch or by the Panel		
4	The Sounder shall be placed in the detection loop only and a separate loop or cables for sounders shall not be used		
5	The sounder shall have a sound pressure level of 90dB and the volume shall be adjusted from the Fire Alarm Panel		
6	The sounder shall be capable of programming at least 32 different tones for alarm detection in different floors or at different time intervals		
6	The Sounder shall consume a minimal current of <5mA and thus allowing to connect at least 25 loop powered sounders in the same loop.		

S. No	Technical Requirement	Compliance Yes/No	Remarks
7	The Sounder shall have a feature of synchronizing with other sounders in the loop		
8	The Sounder shall be loop powered and shall be EN54/VdS approved		

1.1.10 Addressable Conventional Zone Module

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	Addressable interface units will be provided for all non-addressable detectors/devices such as beam detectors or to integrate existing conventional detectors, etc. to assign an address to such detectors and to be compatible with addressable FACP		
2	Each conventional detector will have its own addressable unit in the form of CZIM Modules for individual address. The addressable unit will facilitate connection of non-addressable detectors in the same circuit/loop consisting of addressable detectors.		
3	It shall supervise the circuit of open dry contact I/P device & signal alarms during change of state of detectors		
4	The interface device shall have an LED, which flashes during polling of the FACP		
5	The CZIM shall be capable of powering the Detectors through the Aux Source and shall supervise the cable, aux power and the external power supply. The CZIM shall communicate Faults and Troubles related to Detector, Power supply to the Panel		

S. No	Technical Requirement	Compliance Yes/No	Remarks
6	It shall have 2 inbuilt fault isolator module or the bidder shall consider additional isolator modules		
6	The CZIM shall offer 2 separate zones, 2 Aux power circuits and shall monitor the external power supply and supervise the zone cables		
7	CZIM shall allow to configure the conventional zones with Different EOL and Alarm resistor based on the existing detector type		
8	CZIM shall be EN54 /VdS approved		

1.1.11 Beam Detector

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	The beam detectors shall having a separate Transmitter (Tx) & receiver (Rx)		
2	Beam detectors shall be externally powered via Conventional Zone Interface module (CZIM). The module shall supervise the External Power Supply, Aux Power to the Transmitter and Receiver.		
3	The beam detector shall be suitable to protect the distance from 10 meters to 100 meters range.		
4	The beam detectors shall communicate the ambient reading to the FACP on time to time basis, and the FACP shall make the decision about the current status of the detector, whether it is in fire/pre-alarm/maintenance requirement etc.		
5	Beam detector shall have Response time less than 20sec		

S. No	Technical Requirement	Compliance Yes/No	Remarks
6	The response threshold values, tests shall be as per NFPA 72.		
6	It shall have feature such that in case of accidental change of alignment, it shall report an error, it shall raise a maintenance request to the FACP		

1.1.12 Invisible Multi-criteria Detector

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	Microprocessor Based Addressable Invisible detector for smoke, optical component, for flush fitting in steel-reinforced concrete ceiling or suspended ceilings for Library Area		
2	Having a detection principle of two independent scattering light sensors with sensing volumes directly beneath the detector with features of drift compensation , contamination detection by means of a third optical system, protection against insects by means of a dual evaluation system , protection against external light in accordance with EN54-7 , chamber integrity monitoring, optical fault display , self-monitoring of sensors, programmable for timed automatic sensitivity selections with Junction Box and other accessories as required		
3	The detector shall be EN-54/UL approved.		

1.1.13 Aspiration Detector

S. No	Technical Requirement	Compliance Yes/No	Remarks
1	Aspirating smoke detector, Highly sensitive smoke aspiration system for monitoring of rooms and equipment for earliest possible fire detection with max of 24 aspiration openings and a max pipe length of 180m.		
2	Protected area of max. 2880m² for one detector		
3	Three status displays on housing front panel for "operation", "alarm" and "malfunction"		
4	Adjustable sensitivity of up to 0,05%/m light obscuration		
5	Different sensitive detection modules possible		
6	Settable in day and night operation		
7	Innovative air flow sensor technology - false alarm suppression		
8	Air stream monitoring with air pressure-dependent equalization		
9	Monitoring of pipe for breakage and obstruction		
10	To be integrated in Detector Loop		

1.1.14 Power Cables

The specifications for power cables shall be as below:

1. Conductor material: Stranded Copper
2. Insulation Material: Cables shall be PVC insulated as per application.
3. Voltage grade: 1100 V
4. Armouring: All power cables shall be GI wire armoured.
5. Sheathing Material: Inner & Outer sheaths shall be FRLS PVC

1.1.15 I&C Cables (FRLS)

The specifications of cables shall be as per data sheets in Section D. All multipair & multicore cables shall be provided with 20% (of used pairs/cores) spare pairs & cores for

future use. Cables for Ethernet connectivity shall be CAT 6 cables, which shall be armored. Cables for RS-485 connection shall be twisted pair cables, shielded & armored.

Cable Glands

All cable glands shall be of double compression type with high quality neoprene gaskets. Cable glands shall be of brass with nickel plating.

Cable trays

- Cable trays shall be perforated of hot dipped galvanized steel. Cable trays shall have 50 mm collar height. The cable trays shall be covered type.
- Cables within the hospital block shall be laid on cable trays below false flooring. The cables coming in the beam area shall be allowed to pass through conduits.
- The cables laid between two different hospital buildings shall be laid in conduits in cable trenches.
- I&C Cables and power cables shall be routed through different cable trays to avoid Electromagnetic Interference.
- Minimum 300 mm distance shall be maintained between I&C Cables/24 V DC Power Supply Cables & 415 V AC/ 230 V AC Power Cables. All cable trays shall be provided with 20% spare space for future use.

1.1.16 Fire Proof Sealing for Cable Penetration

Cables/ cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another shall be sealed by a fireproof sealing compound. The fire-proof sealing compound shall effectively prevent the spread of fire from the flaming to non-flaming side, in the event of fire.

1.1.17 Panel Accessories & Wiring

Wiring

All inter cubical and internal wiring for all panels shall be carried out with 1100V grade, stranded tinned copper conductors with PVC insulation. The minimum size of the stranded

copper conductor used for the panel wiring shall be 0.5 mm^2 for analog signals and 1.0 mm^2 for commands. For power supply, the conductor size shall be provided as per the load rating (min. 2.5 sq. mm for 230 V AC). Control & Power wiring shall be segregated and routed in PVC troughs. Different colour wires shall be used for different voltages.

- Engraved core identification plastic ferrules, marked to correspond with the panel-wiring diagram shall be fitted at both ends of each wire. Cross ferruling shall be done. This shall also be applicable for fibre optic cable & cores.
- All spare contacts and spare terminals of the panel mounted equipment and devices shall be wired to the terminal blocks.
- Plug Points and Interior Lighting
- A 5/15 Amp 230V, 1 phase, 50 Hz, AC 3 pin plug point shall be provided in the interior of each panel with ON/OFF control switch and MCB.
- For interior lighting 230V, 1 Phase, 50 Hz, 40W compact fluorescent lamp with operating door switch and protective devices like MCBs shall also be provided.
- Power supply for all exhaust fans shall be provided through MCBs.

Relays

All relays used for interposing shall have at least 2 nos. changeover contacts. The relays shall have status indication and shall be provided with freewheeling diodes.

Labels

All front mounted equipment, as well as equipment mounted inside the panels/control desks shall be provided with individual labels with equipment designation engraved. These shall be phenolic overlays (1.6 mm thick) with black background and white lettering and shall be fixed to the panel by stainless steel screws (counter sunk). The panels shall also be provided at the top with a label engraved with the designation. Lettering for panel designation shall be 6 mm.

The minimum lettering size for instrument/device labels shall be 3mm. The lettering on the labels shall be subject to PURCHASER'S approval. Labels of internally mounted equipment shall be clearly visible.

Earthing

Each panel shall be provided with a safety ground bus & system ground bus made of copper securely fixed along the inside base of the panels. These buses shall be typically of 25 mm wide and 6 mm thick of copper. The safety ground bus shall be properly secured to the plant safety earthing. All metallic cases/frames of relays, instruments, other panel mounted equipment shall be connected to the safety ground bus and shields & drain wires of signal/control cables shall be connected to the system ground bus by independent copper wires of not less than 2.5 sq. mm. The system ground bus shall be electrically isolated from AC mains earthing bus. The system ground bus shall be insulated from the panel body. The insulation colour code for earthing wires shall be green with yellow bands.

1.1.18 Networking to Fire Alarm Control Panel (FACP)

The system supplied under this specification shall utilize node-to-node, direct-wired multi-priority peer-to-peer network operations. The backbone shall be Single mode Fibre optic cable or copper wire. A Minimum of 64 ten loop panels shall be capable of being networked together and each panel shall have capability of addressing 1980 points .The system shall utilize independently addressed, smoke detectors, heat detectors and input/output modules as described in this specification.

The peer-to-peer network shall contain multiple nodes. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes. When a network is wired in a Class B configuration, a single break or short on the network wiring isolates the system into two groups of panels. Each group continues to function as a peer-to-peer network working with their combined databases. If multiple wiring faults occur, the network re-configures into many sub-networks and continues to respond to alarm events from every panel that can transmit and receive network messages. The remote control panel/network nodes shall meet the same requirements as described in control panel section and shall contain Common control switches with minimum 160 character LCD display, as required with Integral power supply(s) with secondary stand-by power. It shall also have signalling line circuits for communications with analogue addressable devices, as required, audio amplification, as required, Notification appliance circuits, as required and auxiliary function circuits and operations, as required.

The network communication shall be based on a Local Area Network (LAN) or MODBUS on RS485. The network shall use a deterministic token-passing method. Collision detection and recovery type protocols are not acceptable substitutes due to life safety requirements.

Failure of any node shall not cause failure or communication degradation of any other node or change the network communication protocol among surviving nodes located within distance limitations.

1.1.19 Interface with PA/GA System

The Fire Detection System shall be hardwired interface with PA system. In case of any emergencies or detection of fire, alarm signal shall send to PA system to activate alarm tone generator and to play recorded message.

1.1.20 Interface with HVAC System

The Fire Detection System shall be hardwired interfaced with HVAC system. In case of any emergencies or detection of fire, affected fire zone AHU, FCU and motorized fire/smoke dampers shall get close.

1.1.21 Interface with Security System

The Fire Detection System shall be hardwired interfaced with SECURITY system. In case of any emergencies or detection of fire, affected zone control doors shall get released.

1.1.22 OEM Requirements

- OEM should have an office as a registered company in India for last 10 years as on the bid issuance date.
- OEM Should have service centre in India form last 10 years
- FAS System should be seamless integrated with Public address system

1.2 CLOSED-CIRCUIT TELEVISION (CCTV) CAMERA

1.2.1 CCTV Camera – Fixed & Dome

CCTV Camera in ROURkela one will be of following minimum Specifications.

Dome & Fixed Camera Cameras		Compliance (Y/N)	Remarks
Sub Items	**Minimum Configuration Requirements**		
Type	Dome & Bullet		

Dome & Fixed Camera Cameras		Compliance (Y/N)	Remarks
Sub Items	**Minimum Configuration Requirements**		
Image Sensor	1/3" Progressive Scan		
Resolution range	(1920 - 2100) x (1080- 1200) complied with SMPTE 274M-2008		
Frame rate	30 fps at full resolution (16:9) or better		
Compression	H.265/H.264 or superior, MJPEG		
WDR Measured according to IEC 62676 Part 5	80 db or better		
Video Streaming	Quad streaming Stream, fully configurable		
Alarm Input and Output	01 I/p, 01 relay O/P		
Network Port	RJ45 10/100 Base T		
Protocol	TCP, HTTP, HTTPS, SMTP, SNMP, SNTP, RTP, RTSP, SSL, 802.1x, QoS, DNS, ICMP, UPNP, DDNS, IP v4 & v6 Remote Administration: Remote configuration and status using web based tool		
Lens	3 to 9 mm		
Focus	Auto focus and zoom		
Illumination / Sensitivity at F1.3, 30IRE	0.3 lux; Mono: 0.03 lux IR Distance, 30 meters or better		
Audio	Built-in Microphone		
Operating Temperature:	- 20° - 50° C		
Video Analysis(edge based)	Object in field, Line crossing , Enter / leave field, Loitering, Follow route, Idle / removed object, Counting, Occupancy, Crowd density estimation, Condition change, Similarity search - licenses for all these analytics to be considered with camera.		
Electronic Shutter Speed (AES)	1/30 s to 1/10000 s		
BLC	Required		

Dome & Fixed Camera Cameras		Compliance (Y/N)	Remarks
Sub Items	**Minimum Configuration Requirements**		
Security	Network authentication with EAP/TLS , Embedded Login Firewall, on-board Trusted Platform Module (TPM) and Public Key , Infrastructure (PKI) support.		
Other features	ONVIF : Profile S Compliant Signal to Noise Ratio: ≥55db		
Local Memory	Minimum 256 GB & shall support uoto 1TB with class6 or higher from day one (during downtime of the connectivity to server, captured data should be stored locally and the same should automatically upload into the storage after restoring of connectivity). Bidder to provide 128 GB SD card with camera.		
Certification	CE,FCC, UL, EN		

1.2.2 CCTV Camera - PTZ

IP PTZ Camera		Compliance Yes/NO	Remarks
Sub-Items	**Minimum Configuration Requirements**		
Image Sensor	1/3" Progressive Scan CMOS or better		
Resolution	1920x1080, complied with SMPTE 274M-2008		
Frame rate	60 fps at all resolutions		
Compression	H.265/H.264 or superior, MJPEG		
WDR Measured according to IEC 62676 Part 5	90 db or better		
Video Streaming	Quad streaming Stream, fully configurable Camera shall have minimum fully configurable 3 h.264/h.265 and 1 M-jpeg		
Alarm Input and Output	01 I/p, 01 relay O/P		
Network Port	RJ45 10/100 Base T		

IP PTZ Camera		Compliance Yes/NO	Remarks
Sub-Items	**Minimum Configuration Requirements**		
Protocol	TCP, HTTP, HTTPS, SMTP, SNMP, SNTP, RTP, RTSP, SSL, 802.1x, QoS, DNS, ICMP, UPNP, DDNS, IP v4 & v6 Remote Administration: Remote configuration and status using web based tool		
Lens	(4.3-4.5) mm - (129-135)mm (F1.6 - F4.4) for 30x Optical zoom, Digital zoom of 16x		
Focus	Automatic with manual override		
Illumination / Sensitivity at F1.6, 30 IRE	Colour: 0.05 lux Mono: 0.01 lux. IR Distance: 170 Mtrs or better(Internal /External with 360 degrees coverage) IR from Camera OEM only		
Audio Compression	Two way Audio : Required Input / Output : 1in and 1out		
Preposition Accuracy	± 0.1°		
Protection:	IP66 enclosure		
Operating Temperature:	-20° to 60°		
Video Analysis (edge based)	Object in field, Line crossing , Enter / leave field, Loitering, Follow route, Idle / removed object, Counting, Occupancy, Crowd density estimation, Condition change, Similarity search - licenses for all these analytics to be considered with camera.		
Electronic Shutter Speed (AES)	1/30 s to 1/15000 s		
BLC	Required		
Defog	Required		
PAN and Tilt Speed	Pan: 0.1°/s - 240°/s; Tilt: 0.1°/s - 120°/s		

IP PTZ Camera		Compliance Yes/NO	Remarks
Sub-Items	**Minimum Configuration Requirements**		
Security	Network authentication with EAP/TLS , Embedded Login Firewall, on-board Trusted Platform Module (TPM) and Public Key , Infrastructure (PKI) support. IP addresses which have never been successfully logged in and had more than 3 failed log-in attempts during the last 20 seconds are blocked and encryption protocol- TLS 1.2, SSL, DES, 3DES		
PAN& Tilt Angle	PAN:360°; Tilt:0°-90°		
Other features	ONVIF : Profile S Compliant Signal to Noise Ratio: ≥55db, Privacy mask supported at least 24 and 256 presets		
Local Memory	Minimum 512 GB & shall support uoto 1TB with class6(during downtime of the connectivity to server, captured data should be stored locally and the same should automatically upload into the storage after restoring of connectivity). Bidder to provide 128 GB SD card with camera.		
Certification	CE,FCC, UL, EN, IEC		

1.2.3 L2-POE Switch

L2- POE - SWITCH		Compliance Yes/NO	Remarks
Features	**Minimum Configuration Requirements**		
Interface	8 × 10/100/1000BASE-T Ethernet (RJ45) with auto-MDIX crossover		
	48V DC 802.3af/802.3at Power-over-Ethernet (PoE/PoE+) on the MS120-8LP/FP model, available on all ports (maximum of 30W per port for PoE+)		

L2- POE - SWITCH		Compliance Yes/NO	Remarks
Features	**Minimum Configuration Requirements**		
	2 × SFP 1 Gigabit Ethernet interfaces for uplink		
	Auto negotiation and crossover detection		
Ethernet switching capabilities	802.1p Quality of Service, 8 queues and configurable DSCP to CoS mapping		
	802.1Q VLAN and trunking support for up to 4,094 VLANs		
	802.1w, 802.1D Rapid Spanning Tree Protocol (RSTP, STP)		
	Broadcast storm control		
	IGMP Snooping		
	802.1ab Link Layer Discovery Protocol (LLDP) and Cisco Discovery Protocol (CDP)		
	802.3ad Link aggregation with up to 8 ports per aggregate		
	Port mirroring		
	MAC forwarding entries: 16,000		
Management	Managed via the web & cloud management platform		
	Integrated with wireless and complete portfolio of IT products and solutions		
	Zero-touch remote provisioning (no staging needed)		
	Detailed historical per-port and per-client usage statistics		
	DHCP, client, and hostname fingerprinting		
	SNMP and Syslog support for integration with other network management solutions		
	Automatic firmware upgrades with scheduling control		
Security	Integrated two-factor authentication for Dashboard management		
	Role-based access control (RBAC) with granular device and configuration control		

L2- POE - SWITCH		Compliance Yes/NO	Remarks
Features	**Minimum Configuration Requirements**		
	SSO, Corporate-wide password policy enforcement		
	IEEE 802.1X RADIUS, hybrid authentication and RADIUS server testing		
	MAC-based RADIUS authentication (MAB)		
	Port security: Sticky MAC, MAC whitelisting		
	DHCP snooping, detection and blocking		
	STP Enhancements include BPDU guard, Root guard		
	IPv4 ACLs		
Remote Diagnostic	Email, SMS and mobile push notification alerts		
	Cable testing and link failure detection with alerting		
	Live remote packet capture		
	Dynamic and interactive network discovery and topology		
	Combined event and configuration change logs with instant search		
Power Over Ethernet	802.3af (PoE) 15.4W per port and 802.3at (PoE+) 30W per port		
	Maximum PoE output: 67/124W		
	PoE available on all ports simultaneously		
Performance	Switching capacity: 20Gbps		
	Forwarding rate: 14.88mpps with standard packet size		
	Jumbo frame support (9578 byte Ethernet frame)		
	Flow control support		
Power	Power input: 100 - 240 VAC, 47-63 Hz		
	Power consumption: 5 - 161W		
	External power supply for MS120-8, MS120-8 LP		

L2- POE - SWITCH		Compliance Yes/NO	Remarks
Features	**Minimum Configuration Requirements**		
Mounting	Wall or utility board mountable with included mount hardware		
	Desktop-mountable with included feet		
	Kensington lock slot included		
Environment	Operating temperature: 32°F to 104°F (0°C to 40°C), 45°C		
	Humidity: 5 to 95% non-condensing		
	Fanless operation		
Regulatory & Certifications	CSA-US (US, Canada)		
	FCC (USA)		
	IC (Canada)		
	CE (Europe)		
	RCM (Australia/New Zealand)		
	RoHS		

1.2.4 Intelligent Video Management Software (IVMS)

- The Network Video Management Software for IP network-based video management system (called “system” as described below) shall be a Windows-based application software, capable of recording JPEG or MPEG-4, H.264, H.265 video, or dual JPEG/MPEG-4, H.264 streams from a camera, G.711 or G.726 audio, as well as metadata.
- The system shall support OEM network cameras and 3rd party ONVIF compliant camera.
- The system shall have the ability to display, record, and playback video from cameras located at remote multiple locations over an IP network simultaneously.
- The system shall support the following recording modes: manual, schedule based, alarm, and event (or activity). Additionally, the system shall support rule or filter based triggered recording when used with camera that support intelligent motion detection or object detection of the OEM.
- The system shall also have a quick recording configuration capability with a simple wizard and shall:

I. Allow the user to select either schedule recording or alarm recording.
II. Alarms shall be based on Video Motion Detection capabilities of the camera (edge) as default and if the camera does not have motion detection capability, then VMD of the system shall be used.
III. Parameters that were set with the wizard shall be capable of being changed manually.
IV. The operator with proper rights shall be able to manually record video by clicking the REC button on the GUI or configure record settings manually without using the wizard.
V. Pre- and Post-alarm duration shall be configurable for all event or alarm-based recording.

- The system shall be capable of simultaneous local and remote viewing, playing back, recording, and exporting video.
- The system shall support simultaneous Video and Audio export.
- The system shall have the capability to use any of the following as a trigger to perform a given action:

  I. Sensor Input trigger to the camera
  II. Camera based Video Motion Detection (VMD) trigger
  III. Recorder (system) based VMD
  IV. Video Motion (Analytics) Filters (VMF).
  V. System Alerts
  VI. 3rd Party I/O Box.
  VII. Logical Sensor Input (Requires HTTP API available upon request)

- The system shall be capable of recording and storing images at frame rates between 1 to 25 frames per second on a per camera basis.
- The system shall have three types of searches on the main GUI:
  I. Date/Time.
  II. Quick Playback.
  III. Alarm history.

- The system shall also have a detailed search capability providing the operator with a 'Search' GUI that allows multiple (simultaneously) as well as single camera to be searched.
- The system, via PC mouse and keyboard, shall be able to auto center any on-screen PTZ stream or drag-and- zoom on a specific area.
- The system shall support the import and export of site layout images in BITMAP and JPEG file formats.
- The system shall be configurable for centralized server management in a master/slave configuration i.e. on server & client mode.
- The system shall support both the Intelligent Motion Detection (IMD) and intelligent Object Detection (IOD) functions of the camera. The IMD function shall be capable of triggering an alarm, which shall minimize false alarms caused by noise and repetitive motion patterns. The IOD function shall be capable of detecting an object which has been taken away or left behind. These functions shall be mutually exclusive for each camera.
- The system shall support the following Video content Analytics based on camera's metadata:
  I. Detect objects that match the detection criteria for objects entering into a user defined area.
  II. Detect objects that match the detection criteria for objects exiting a predefined area.
  III. Detect an object that stays within a defined area longer than the set limit.
  IV. Triggers an alert when the number of detected objects meets or exceeds the detection criteria for object number within the configured area.
  V. Detect objects crossing the set virtual borderline, going in either directions or a specified direction.
  VI. Detect objects that are left unattended or removed by comparing the retained background video data and live video data.
- The Media File Player application software shall be bundled with the Network Video Management Software or be provided free of charge, to allow playback of encoded video &/or audio files on a Windows-based PC.
- The system shall be capable of sending live audio to network cameras that support an active speaker output.

REMOTE CLIENT REQUIREMENTS:

The system shall include client software to allow a user to remotely configure the server system, view live images, play back and search the desired recorded images. The client software shall be capable of the following items similar to the server system:

1) Live video monitoring from selected cameras
2) Recording configuration (manual/schedule/alarm/event-based) playback video.
3) Easy search of recording images camera's metadata information.
4) Search by Time and Date, Camera, REC Type (Schedule, Manual, Alarm, Event), Video Motion Filter (VMF) and post Video Motion Detection (VMD).
5) Camera PAN/TILT/ZOOM Control and Tour operation, Two Way Audio Support.
6) Hotspot monitor.
7) Set a number of triggers to perform actions including, triggering alarms, layout changes, camera tours, e-mail notifications, and more. Up to 100 actions can be scheduled.
8) Search by Alarm Type, Display Type, Audio/ Video Log and Export.

ITEMS	IVMS - (SOFTWARE FUNCTIONS)	
	Features	**Minimum Configuration Requirements**
IVMS	General	- Management and viewing interface for IP cameras, IP domes, encoders, DVRs, NVRs, etc.
		- Application in local area network and wide area network
		- E-map function
		- User permission management
		- Embedded web server supporting web browsing function
		- Friendly user interface providing easy operations
	Network	- NTP protocol supported
		- IP Server, Dyn DNS for dynamic IP connection
		- Two-way audio and broadcast function
		- Search online devices automatically (SADP)
	Live View	- Different view modes available in live view and playback

ITEMS	IVMS - (SOFTWARE FUNCTIONS)	
	Features	**Minimum Configuration Requirements**
		- Standard screen layout: 1, 4, 6, 8, 9, 13, 16, 25, 32, 36, 64; Wide screen layout: 4, 6, 7, 9, 12, 16, 24, 36, 48
		- Main/auxiliary screen live view - Manual recording and picture capture supported
	PTZ Control	- Local and remote PTZ control supported
		- Control keyboard and USB joystick supported
		- Auxiliary focus function
		- 3D positioning function
	Record	- Remote manual recording supported
		- Schedule recording, event recording supported
	Playback	- Local and remote playback supported
		- Up to 16-ch synchronous playback supported
		- Instant playback supported
		- Event playback supported
	Alarm Management	- Camera Linkage for tampering alarm/video loss alarm
		- Manually turn on/off alarm output
		- PIR alarm, wireless alarm and emergency alarm supported
		- Multiple linkage actions supported
	Video Wall Display	- Multi-screen display mode supported
		- Video wall display for playback supported
		- Alarm triggered video wall display supported
	Backup	- Import and export configuration file - Log search and backup

1.2.5 Camera Mount

- The camera mount should be of the same make as that of camera and suitable for the model number offered as specified by the manufacturer.
- It shall be compact and indoor / outdoor type as required.

- It shall be support the weight of camera. Camera accessories such as housing pan & tilt head in any vertical or horizontal position.
- It shall be weatherproof in case of outdoor mounting.

1.2.6 Speed Dome Controller/PTZ Controller

- Speed Dome Controller should have variable speed joystick, LCD for programming and it should be able to control the Encoders as well as speed dome for PAN / TILT / Zoom functions.

1.2.7 Video Wall Rack

The video wall mountings should be of powder coated MS frames/supports and should be strong enough to take care weight of all Monitors. It should be suitably fabricated in such a way that only screens of monitors should be visible outside. Power supply wiring with suitable capacity sockets /earthing should be neatly installed on the rack. Video wall computers should also be enclosed in the rack. The supporting frames of monitors should not sag due to its weight.

1.2.8 Cables

Connectivity	Cable Type	Connector
Camera to L2 Switch	UTP CAT 6	RJ45
L2 Switch to L3 Switch in control room	Single Mode Fibre	SC / OFC,
L3 Switch to Video Wall/Switches	UTP CAT 6	RJ45
From L3 switches to NVR/NAS Box	UTP CAT 6	RJ45

1.2.9 Installation of UTP cable

- Cables should be dressed and terminated in accordance with the manufacturer's recommendations and/or best industry practices.

- Pair untwist at the termination should not exceed one-half an inch.
- Bend radius of the cable in the termination area should not be less than 4 times the outside diameter of the cable.
- The cable jacket should be maintained as close as possible to the termination point.
- Cables should be neatly bundled and dressed to their respective panels or blocks. Each panel or block should be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- The distance between UTP data cable and any power cable should be more than 4 inches.
- Each cable should be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view should not be acceptable.
- Cables should be installed in continuous lengths from origin to destination (no splices).
- Horizontal distribution cables should be bundled into groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
- Cables should not be attached to ceiling grid or lighting support wires.
- Any cable damaged or exceeding recommended installation parameters during installation should be replaced by the contractor prior to final acceptance at no cost.
- A self-adhesive label or PVC marker ferules should identify the Cables. A cable label should be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate. Similar label or marker ferrules should also be placed on a section of the cable near to the patch panel termination.
- Pulling tension on 4-pair UTP cables should not exceed 25-pounds for a single cable or cable bundle. The pathway should be adequately sized so as not to exceed the 80% cross-section fill of cables. The pathway should be securely installed in the facility.
- Care should be taken when pulling cables into trucking to avoid damage due to snagging. Trucking partitions should be used to separate the data cables from power, and bridges should be used where data cables have to cross the mains.

1.2.10 Instruction of OFC cable

- Proper cable preparation is essential for splicing and installation. The following points outline some special precautions which are specific to fibre optic cable installation and therefore need to be noted.
- Fibre Stress: The fibres in the cable should not be subject to any endue stress. This means that if the cable is to be pulled into a long duet route hen the specialized equipment and procedures should be used. As well, if the cable runs vertically for a significant length (more than 10m) then loop should be provided every 10m.
- Bend Radius: The cable manufacturer's minimum bend radius should be observed. i.e. there should be no bends tighter than specified either during installation or once cable has been seen fixed.
- Cable Ties: If cable ties are used, then it is very important that they are not over tightened, thereby causing localized bending and fibre stress.
- Spare Cable: At least 5m of cable should be left at each end to allow testing, positioning of enclosures, spare fibre for repairs etc. Where appropriate, spare loop of cable should be included along the cable run to assist repair in case of accidental damage.
- Labeling; All cables and cable end should be labeled clearly.
- Cable End Protection: Where cable ends are to be left exposed then they should be sealed with heat shrink caps to prevent ingress of dirt or moisture.
- Earthing: In many circumstances completely non-metallic fibre optic cables can be used to eliminate all earthing problems. If metallic elements are present then they should be earthed in accordance with the installation.

1.2.11 Light guide Interconnect Unit (LIU)

It should be installed for terminating the OFC cables. It shall provide minimum bending radius and the splice trays shall function as a splice cover for pigtail splicing. It shall be of complete Aluminium fully powder coated. Cable glands shall be provided for secure anchoring the incoming cables. Rubber grommets shall be provided at the cable entry point for tight sealing. The splice tray shall also be of Aluminium powder coated with splice holder. Cable spools shall of flame retardant.

1.2.12 OFC Patch Cords

It shall be suitable for single mode SC type fibre cable connectors with plastic moulded plug type connectors. Standard 2.5 mm ceramic ferrules shall be used. It shall be compact and easy to connect.

1.2.13 Power Wiring System

Rigid PVC (heavy duty) Conduit Wiring System as per IS: 9537.

1.2.14 Conduits

- All rigid conduit pipes shall be of PVC and be ISI marked. The wall thickness shall be not less than 1.6 mm for conduit up to 32 mm dia and less than 2 mm for conduits above 32 mm dia.
- The maximum number of PVC insulated sables conforming o ISI: 694-1990 that can be drawn in one conduit as per standard norms. Conduit sizes shall be selected accordingly in each room.
- No conduit less than 20 mm in diameter shall be used.
- Flexible conduits will only be permitted for interconnections between switchgear, DB's and conduit terminations in wall.
- All flexible conduits used in the system should be Halogen free, flame retardant and self-extinguishing polyamide conduits.

1.2.15 Wires

Wires shall comply the following features:

- PVC insulated with a rating of 105 deg. C bright annealed electrotype grade (99.9% pure) copper standard conductors multi drawn simultaneously (Unilay, twisted conductors) for uniformity of resistance, dimension and flexibility.

Color coded as below:

Phase – R	Red

Phase – Y	Yellow
Phase – B	Blue
Neutral	Black
Earth	Green

1.2.16 Installation

- The conduit work of each circuit or section shall be completed before the cables are drawn in.
- Conduit pipes shall be joined by means of couplers and accessories only.
- Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of conductors while pulling through such pipes.

1.2.17 Fixing conduits in chase

- The conduit pipe shall be fixed by means of staples hooks or by means of saddles, not more than 60 cm part, or any other approved means of fixing.
- All joints of conduits pipes shall be treated with some approved preservative compound to secure protection.

1.2.18 Fixing switch boxes and accessories

- Switch boxes shall be mounted flush with the wall. All outlets such as switches socket outlets, etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

1.2.19 Bunching of cables

- Cables shall be always be bunched so that the outgoing and return cables are drawn into the same conduit.

- In case of three phase loads, separate conduits shall be run for each phase from the distribution boards to the load points, or outlets as the case may be.

1.3 AUDIO & VIDEO SYSTEM – FOR AUDITORIUM-HALL ONLY

Items	Item Description/ Minimum Specifications
15" Speakers	Supply Installation Testing & Commissioning of 15" Two-Way System in a Trapezoidal Enclosure; 600W @ 8 ohm Continues Power Frequency 45Hz to 20KHz sensitivity 100dB
Array Frame	Supply Installation Testing & Commissioning of Array Frame for Suspending up to 6 Enclosures with 10:1 Design Factor. Includes 4 x Quick Release Pins, 2 x Shackles, 2 x Drop Levers. (For Speaker Installation)
Side Wall Speaker Mounting Kit	Side Wall Speaker Mounting Bracket
Bass Subwoofer	Supply Installation Testing & Commissioning of 2 x 18" Bass reflex Subwoofer system with 1000 watt or better Frequency response 25-200HZ long term power handling, 220 Magnetism with dual 18" LF driver,
2-Way Monitor System	Supply Installation Testing & Commissioning of Two-Way Monitor System 70 Hz - 18 kHz (-10dB) frequency response, 95 dB SPL sensitivity @ 1W / 1m, long term power handling 200W, max sensitivity 115dB.
Ceiling Speaker	Supply Installation Testing & Commissioning of 6"+1.5" Coaxial Ceiling speaker with ABS cover, 40W, 100V, cutout 185mm, ABS baffle & back cover, metal grille. The Speaker shall have following Feature: Max SPL > 102 dB, Frequency Response 90-20kHZ. The Speaker shall have Multiple tapping
Power Amplifier 2-Ch. 1600W+1600W	Supply Installation Testing & Commissioning of Power amplifier, Dual channel 1600 + 1600 Watts RMS @ 8 ohms, Stereo power THD<0.1%, S/N Ratio 112dB Front-to-rear air flow, temperature controlled speed, Short circuit, open circuit, direct voltage, high temperature, radiofrequency, ultralow frequency, current peak limitary input connector 3-pin XLR, electronically balanced (Loc: Projector Room)

Items	Item Description/ Minimum Specifications
Class-D Digital Power Amplifier - 240W	Supply Installation Testing & Commissioning of 240W RMS dual Channel Class-D Digital Power Amplifier with Switch power technology for power electricity saving. Amplifier shall have Following Features: 240W RMS per Channel, Amplifier Output 100V, Short Circuit, Power, Temperature, Overload Protection, Auto Cooling Fans. THD <0.1%, Frequency Response 20Hz - 20kHz, AC & DC Fuse, SNR >80dB. (For Ceiling speakers) Loc: Projector room
32-Ch. Mixing Console	Supply Installation Testing & Commissioning of 32 channels Mixing console with Mono Input 24 Channel, Stereo Input 4 group, Mono Insertion Channel 24 Channel, Phantom power 48V, Frequency Response 20Hz - 20kHz, Channel Crosstalk less than 90dB, S/N Ratio 83 dB, Gain difference between Channel less than 2 dB, Distortion degree less than 0.02%, 21 Kind of DSP Effects. (Loc: Projector room)
8-Ch. Mic & Loudspeaker Management System	Supply Installation Testing & Commissioning of 8-channel Phantom Power Microphone/Line input, 8- channel circuit Output; Loudspeaker Management System Frequency Response 20Hz ~ 20KHz, THD <0.003%, Channel Separation >92dB,Seperate Mute Control each channel, CMRR>80dB, 8 independent parametric EQ, adjustable gain range up to 20dB, With, RS232 and internet to connect PC, High-speed processing DSP Chip, the new generation of AFC algorithm to eliminate the feedback faster and make system more stable. Application includes Auto Mixer (Limiter threshold and Gain), Routing, Audio Processing and special signal extension Processing.
Gooseneck Microphone	Supply Installation Testing & Commissioning of 50cm gooseneck cardioid Microphone, table top type polar pattern super heart-shape sensitivity -35dB frequency 60-14Khz output impedance <200Ohm operating Voltage DC9V(At podium)
Dynamic Microphone	Supply Installation Testing & Commissioning of Dynamic Vocal Microphone with cardioids polar pattern, frequency response 70Hz - 20kHz (@ 1 cm: 20Hz - 18kHz), THD 147/156 dB, Impedence <=600 ohms (Stage performance)
Floor Box	Supply Installation Testing & Commissioning of Floor Box for Connecting Mic (2 XLR Connector).

Items	Item Description/ Minimum Specifications
Handheld Wireless Microphone	Supply, Installation, Testing & Commissioning of handheld Wireless Mic system set with two transmitters dynamic microphone, Frequency Response 40Hz-15,000 Hz, Surge mode PLL Phase lock, Dynamic Range >90dB, THD < 0.5%, S/N ratio > 90dB, Carrier frequency range 720 - 830 MHz, Power Consumption < 85mA.
Microphone Tripod - Long	Microphone Tripod stand with Long Arms of Aluminium
DVD Player	Supply Installation Testing & Commissioning of Professional DVD player make Philips or equivalent
Speaker Wiring - 2x1.5sqmm with conduits	Supply Installation Testing & Commissioning of Wiring for Speaker 2x1.5sqmm shielded cable system including miscellaneous connectors in PVC conduits.
19" Equipment Rack	Supply Installation Testing & Commissioning of 19" Rack Mount Enclosure for Installing all sound reinforcement System and Video Project System. 24 U
2Cx1.5 Sq.mm Shielded Microphone Cable	Supply and fixing 2C x 1.5 Sq.mm shielded Microphone cable
Connector Accessories	Supply Installation Testing & Commissioning of Connector accessories
Projection System	Projection System with WUXGA 1-Chip DLP Projector . with native resolution of 1920 x 1200 8500 ANSI lumens , contrast ratio 10000:1 optional Wide projector along with accessories.
Long Throw Lens for Projector	Long Throw Lens for Projector as Suitable
Projector Screen	Supply Installation Testing & Commissioning of 220-250" Diagonal or More Projector Screen with Motorized and Tensioned.

Items	Item Description/ Minimum Specifications
8x8 HDMI Matrix Switcher	8 x 8 HDMI Matrix Switcher with HDCP Compliant, HDMI and HDCP as per technical specification. Input and Output: supporting 8 signal input and 8 signal outputs. Card-insert construction: input signal types: VIDEO, VGA, YPbPr, DVI, HDMI, 3G-SDI, Fiber, HDBaseT; output signal types: HDMI, VGA format, DVI, HD BaseT, Fibre. Card design is easy for extension and change. Supporting any output of DVI, HDMI, HD BaseT, Fibre. Seamless switching function. Supporting embedded dual IR and RS-232 control signal switching function (need to match up with HD BaseT, FB board card and relevant transmitter) Supporting HDCP management, encryption and decoding HDCP content can be set up to make sure that the display of signal source is normal. Supporting EDID management, it can stock 8 groups EDID data's. The output equipment EDID can be read and the stocked EDID can be used to any input card, which can send the EDID code to EDID storage area by the serial port and the current output EDID code can be read by the serial by the serial port. power-failure memory function and site memory function, and power-failure site protection function; it can preserve and invoke 10 switching status. Supporting forward direction high speed channel and embedded control signal separation switching mode. Supporting entire HD: HDPC:1920x1200P@60_24bit, HSTV:1920x1080@60_36bit, Supporting entire HD: HDMI 1.4, HDCP 1.4, and DVI 1.0 protocol. Supporting high color depth and high 3.25Gbps speed. 2 RS-232 communication interfaces.1 network interface and can be remote controlled by Ethernet, supporting 8 user connection simultaneously.
HDMI Tx & RX	HDMI Transmitter and Receiver
HDMI Cable - 5M	HDMI Cable 5 Meter
HDMI Cable - 10M	HDMI Cable 10 Meter
Connector Accessories	Supply Installation Testing & Commissioning of Connector accessories
Presentator	Presentation Point Having HDMI Input

Items	Item Description/ Minimum Specifications
HDMI Audio Deembedder	HDMI Audio Deembedder, with 1 HDMI connector Input & 1 HDMI connector, 1 TOSLINK® optical digital audio connector, 1 S/PDIF digital audio on an RCA connector, 1 unbalanced stereo audio on a 3.5mm mini connector Output as per technical specification.
Digital Podium	Intellectual Digital Podium Broadcasting system with LCD display, U socket and Mic/Line Inputs. Frequency Response 100Hz~16, 000Hz, S/N Ratio >45dB .
Cat-6 Cable - Loose	CAT 6 Cable

1.3.1 Class-D Digital Amplifier

1. All amplifiers shall be power amplifier with High quality speech and Music broadcast. The power amplifiers shall have adequate continuous (RMS) power output to meet the requirement of the configuration. The unit shall can deliver the rated output power with less than 0.1% harmonic distortion in the design bandwidth. The amplifier shall have a broad band frequency response of 40 Hz to 20 KHz. The output voltage and impedance shall meet with the system requirements. Amplifiers shall be protected against over loads and output shorts and a special thermal overload on the heat sink.

2. The Amplifier shall be Class –D Amplifier have one channel, Two Channel, Three Channel and four channels' each channel have rated power 120/240or 500W. The Amplifier shall have switch power technology for power electricity saving, sleep mode is automatically enabled when no signal input is detected.

3. Amplifier shall have AC 115V or 230V power supply and DC 24V input, having separate fuse for each channel. The Amplifier shall be connected through balanced audio input and shall work on 100V Speaker Line.

1.3.2 Projection Screen

- Screen Size - 150" diagonal

- Electrically operated 230 voltage for Up & Down, shall have specially designed motor mounted tensile the roller with a patented noise silencer to be three wire quick

reversal type, oiled for life with automatic thermal overload cut-out, Integral gears, capacitor and an electric brake to prevent coasting

- To have preset but adjustable limit switched to automatically stop picture surface in the Up and down position. The roller to be of rigid metal, 3" In diameter Screen fabric to be flame retarded and mildew resistant fiber glass with matte white, with black masking borders standard. Bottom of fabric shall be formed into a pocket holding a 3/8" diameter metal rod. Case to be - 22-gauge embossed steel, hexagon in shape with back to prevent scraping fabric Powder coated, Caps shall form sturdy brackets for wall or ceiling installation.

- To be complete with three positions control in box with cover plate

1.3.3 Presentation VGA Switcher

VGA SWITCHERS	
Features	**Minimum Configuration Requirements**
Module	4x2 VGA
Input	4 VGA
Output	2 VGA
Bandwidth	400MHz
K Factor	< 0.05%
S/N Ratio	75dB
Controls	22 front panel buttons, RS-232, RS-485, Ethernet
Scaling	Switcher should have either Built in Scaling Facility or Additional Scalar need to take for HDMI Output

1.3.4 Cable Cubby

- Smart solution for conference table.
- Convenient access of different types of cables.
- Hydraulic Mechanism is used
- Self-fitting clamp easy to install
- Available in Rectangular shape
- Available in Black / White anodized Top Surface
- Below features should be available min.

- VGA, HDMI, AUDIO, VIDEO, LAN, POWER

1.3.5 Speaker Cable

- All cables associated with PA system shall be of following specifications:
- The 2-core speaker cable will be connected to the speakers by screw terminals before which it shall be crimped using 1.5 sq. mm. Bootlace lugs. Care must be taken for avoiding any single strand of wire shall not come out of Lug & screw terminals to avoid noise & leakage.
- Flexible Copper Conductor of cross section 1.5 Sq. mm / 2.5 Sq.mm PVC insulated, PVCFRLS sheathed control Cable as per IS 694.
- These Cables shall be laid in G.I. Conduits concealed/surface.

1.3.6 Microphone Cable

- 2 Core 1.5 SQ mm Shielded Microphone Cable as per Approved makes

1.3.7 Installation

- Installation shall be as shown on the drawings, and as recommended by the major equipment manufacturer.
- All cables, junction boxes, cables support and hangers shall be concealed in finished areas and may be exposed in unfinished areas.

1.3.8 Training

The contractor shall provide the customer with details of the training required by personnel to operate and maintain the PA system. The Contractor and the customer shall jointly agree the number of staff to attend the training courses.

1.4 PUBLIC ADDRESS SYSTEM (BUILDING)

Equipment Specifications

1.4.1 Network controller

S.No	Technical Specification	Compliance (Yes/No)	Remarks
1	MAKE/Model		
2	EN-54 Certified IP based EVAC PA controller capable of adding 12 zones in the system and expandable upto 150 zones		
3	14x 4 Audio matrix with full DSP functionality		
4	8 audio inputs, 4 audio outputs, 4 channel output matrix.		
5	Shall support amplifier redundancy		
6	12 speaker line outputs.		
7	8000 fault, warning and event conditions log.		
8	Built in message manager for 100 emergency/business calls up to 85 minutes.		
9	18 control inputs and 19 control outputs.		
10	Impedance measurement and Pilot Tone supervision for speaker line monitoring.		
11	The controllers shall be able to exchange audio signals over the network without the need of a running PC/server, software dependent solutions shall not be accepted.		
12	Multiple controllers can be networked over IP using Dante audio up to 16 digital audio input signals and 16 digital audio output channels with low latency.		
13	Audio flows Up to 16 × 16 simultaneous audio streams@48kHz.		
14	Frequency response (ref. 1 kHz) 20 Hz to 20 kHz (-0.5 dB)		
15	Signal-to-noise ratio (A-weighted): Line in to line out: 106 dB typical		

S.No	Technical Specification	Compliance (Yes/No)	Remarks
16	THD+N < 0.05%		
17	Sample rate 48 kHz, DSP processing resolution 24-bit linear A/D and D/A conversion, 48-bit processing		

1.4.2 Router

S. No	Technical Specification	Compliance (Yes/No)	Remarks
1	MAKE/Model		
2	EN54 Certified EVAC Router for adding 24 zones in the system		
3	2-in-6 matrix.		
4	20 Control Inputs, 26 Control Outputs.		
5	'Shall support amplifier redundancy.		
6	Impedance measurement and Pilot Tone supervision for speaker line monitoring.		

1.4.3 Power amplifiers

The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V and 70V by changing jumpers.

It should have at least the following functionalities:

S. No	Technical Specification	Compliance (Yes/No)	Remarks
1	EN-54 certified 2x 500W Class D, high efficiency amplifier.		
2	70/100V loudspeaker output voltages, 4 automatic selectable audio inputs , local input for audio source.		

S. No	Technical Specification	Compliance (Yes/No)	Remarks
3	THD ≤1%. Frequency response, ref. 1 kHz, rated load, -3 dB : 50 Hz to 25 kHz.		
4	Signal-to-noise ratio (A-weighted) > 104 dB.		
5	Audio input level limiter, RMS output power limiter, high temperature, DC, short circuit, mains undervoltage protection, DC supply undervoltage protection, inrush current limiter, ground fault		

1.4.4 Call Station

S. No	Technical Specification	Compliance (Yes/No)	Remarks
1	EN-54 certified Call Station with extension keypad to with minimum 35 programmable keys for Zone selection, source selection, level control, emergency on/off, message on/off, failure acknowledge/reset		
2	Switching output trigger on/off or 0 to 10V, select scheduled events, scheduled event on/off.		
3	Multilanguage LC display(122 × 32) pixel ,Five menu/function keys		
4	Gooseneck microphone with supervised electret microphone		
5	Pop shield and permanent monitoring, integrated loudspeaker for system sounds.		
6	The call station should have the provision to be configured as a numeric keypad.		

1.4.5 Ceiling Type Loudspeaker – 6-Watts

A flush-mounting ceiling loudspeaker is available for general application. These full range loudspeakers are suitable for both speech and music reproduction .The speaker assembly consists of a single piece, 6 W loudspeaker and frame with a 100 V matching transformer mounted on the back.

S. No	Technical Specification	Compliance (Yes/No)	Remarks
1	6W ceiling mount speaker Make/Model		
2	- Max Power: 9W,Rated Power: 6Watts, Power Tapping: 6/3/1.5W		
3	- Effective frequency range(-10 dB) :150 Hz - 15 KHz		
4	- SPL at rated power (1Khz at 1 m) 108.8 dB		
5	- Opening Angle 1 KHz / 4 KHz (-6 dB): 180/45		

1.4.6 Ceiling Type Loudspeaker – 20-Watts

S. No	Technical Specification	Compliance (Yes/No)	Remarks
1	20W ceiling mount speaker Make/Model		
2	- Rated Power: 20Watts, Power Tapping: 6/3/1.5W		
3	- Effective frequency range(-10 dB) :100 Hz - 15 KHz		
4	- SPL at rated power (1Khz at 1 m) 104 dB		
5	- Opening Angle 1 KHz / 4 KHz (-6 dB): 176/44		

1.4.7 Bidirectional Loudspeaker

S. No	Technical Specification	Compliance (Yes/No)	Remarks
1	12 Watt wall mount bidirectional speaker with excellent speech & music reproduction. Make/Model		

S. No	Technical Specification	Compliance (Yes/No)	Remarks
2	The cabinet should have two dual cone loudspeaker drivers, mounted on an angled baffle, providing a wide opening angle.		
3	Max Power: 18W,Rated Power: 12Watts, Power Tapping:12/6/3/1.5W		
4	Effective frequency range(-10 dB) : 140 Hz to 20KHz		
5	SPL at rated power (1Khz at 1 m) 97dB		
6	Opening Angle 1 KHz / 4 KHz (-6 dB): 270° / 165° Safety acc. to EN60065		

1.4.8 PA Equipment Cabinets

The PA equipment shall be of field proven and rugged construction. The system shall take future requirements into consideration. A minimum of 25 % spare amplifiers shall be supplied for future expansion. In addition, 20 % of unused shelf space shall be available in the cabinets.

- Free-standing (2050 H x 800W x 800 D) mm standard front-access 19" 42U cabinets shall be provided by CONTRACTOR. Colour to be RAL 7032.
- The equipment racks shall be fitted with glazed front doors and a plain back door.
- The battery and MDF rack shall be fitted with plain metal doors.

The PA/GA equipment rack shall house the following equipment:

- Central monitoring unit for sound broadcasting network and messages
- EVAC Monitoring module for 3 lines of speakers and amplifiers
- Signal processing units,

- Amplifiers and 100-V line transformers,
- MDF with cable gland.
- Control and zone selection circuitry,
- PAS Access Units and interface circuitry,
- Fault monitoring equipment,
- Redundant alarm tone generators,
- Built-in testing unit,
- Access and monitor panel,
- Alarm inhibit switch,
- Battery charger.

19 "Equipment Rack,16U Made of MS for housing of all above equipment , front lockable glass door, Fan tray from Colling, Caster wheel base , Main Panel with Spike Buster, Individual FUSE power supply unit, including all internal wiring/ interconnection as required

The PA equipment racks shall be equipped with a front panel alarm inhibit switch to isolate the related PA system from the Fire equipment in order to prevent the accidental activation of the Fire Alarm during maintenance activities. The switch shall be equipped with a key to prevent unauthorized use. The alarm inhibit switch shall provide a feedback loop to the Fire system (open when the alarm is inhibited). A red/green front panel LED indication on the Access Units shall inform the operators of the status of the two Alarm Inhibit Switches.

1.4.9 Network Switch for PAS

Network Switch with 1 Gbit or higher with hardware switching capabilities. (Optional) IGMPv3 or IGMPv2 snooping.

To optimize bandwidth usage, IGMP snooping can be used. This is useful in systems with >10 multicast channels, although not absolutely required. Sufficient performance for handling a large number of IGMP query responses, depending on the number of (directly or indirectly) connected devices to that switch. Hardware support for IGMP is strongly recommended

1.4.10 MDF for PAS

All PA/GA cable pairs shall be terminated in MDF including:

- Loudspeaker distribution cables,
- Interconnecting cables to control points,
- Interconnecting cables to Fire system.

High voltage terminals shall be kept segregated from other terminals and covered with transparent Perspex panels.

The MDF shall be equipped with screw-type terminal blocks.

Four (4) terminals shall be provided for each individual loop. The MDF shall be equipped with facilities for connecting, disconnecting and cross-connecting field-side and amplifier-side wires. All terminal blocks shall be fitted with markers for easy identification.

The MDF shall be equipped with separate earthing facilities for terminating the dual steel tape armor and the screens of each loudspeaker distribution cable. The cable screens shall be connected to the isolated earth bar, the armors to the protective earth bar.

1.4.11 PAS Cables

All indoor PA/GA distribution cables shall be unarmoured /armoured and fire-resistant; while the outdoor PA distribution cables shall be armoured and fire-resistant cables.

This requirement also applies to the power cables feeding the PA Central Equipment Racks and to interconnecting cables with the control points.

Features	Descriptions
Flame resistance:	In compliance with IEC 331
Conductors (LS loops):	2 pairs, 1.0 sq. mm stranded tinned copper wire
Insulation:	XLPE
Twinning:	Lay length not to exceed 70 mm
Screening:	Pairs to be individually screened

Features	Descriptions
Inner sheath:	Low Smoke, zero halogen (LSZH)
Armour:	Dual steel tape
Overall Outer sheath:	Fire Resistance Low Smoke
Outer sheath colour:	Black

1.4.12 Power Supply

- PA Systems shall be powered from 230VAC 50Hz power supply (UPS).
- The UPS are themselves shall be power from the facility Essential power mains. As per safety requirement, the UPS battery capacity shall be design such that the PA/GA system must be able to operate for 60 minutes under continuous alarm.
- Interface with the Fire detection and alarm System

1.5 DIGITAL SIGNAGE

1.5.1 Specification of Digital Signage

- One point of operation with live screenshots, last seen time and colour coding support for status of players/locations
- Dashboard to trigger automatic e-mails in case any location is down
- Multi language input and display support along with animations capability for layers (including transition animations, movements, effects and time)
- Selection to add multiple layers on top of each other with transparency control of each.
- Cropping and clipping of videos in designer
- Show live weather with support for Tier 1, Tier 2 and Tier 3 cities (many added and more being added); along with forecast, sky condition and present conditions.
- Support remote/NOC execution of RS232 commands on the media players to manage the attached hardware (if they support RS232 commands)
- Instant emergency alert messages overriding the playback schedule, can be manual, can be automated, and can link to state/district level emergency messages.

- Must have API support
- Database Support for XML, Oracle, Google Spreadsheet, Google Calendar, Microsoft Exchange, SQL Server, Excel, CSV, etc.
- Create your own QR codes in designer
- Manage and control players remotely from the NOC centre.
- Should be able to use IPv6 protocol.
- Smart transfer technology to avoid re-downloads of existing content.
- Store and play technology ensures continuous playback even if the network gets disrupted between the NOC centre and media player.
- System watchdog for auto recovery of software/OS level minor faults.
- Logging support: Provides details of schedules sent, bandwidth used, downtime, uptime, content deployed, working status etc.
- Run Digital Signage and Interactive content simultaneously at the same time with an interactive idle timeout.
- Should be private network only. (Hosted solution on own premise).
- During no point of content transfer screen should be left blank.
- Should be windows desktop application based system.
- Display areas cropping of live capture/streaming inputs.

SMART DISPLAY		**Compliance Yes/NO**	**Remarks**
Features	**Minimum Configuration Requirements**		
Digital Screen	Size- 46" Inch		
	Resolutions -1080p (1920x1080 Pixel) FHD		
	Mode -Landscape and Portrait Modes		
	Aspect Ratio - 16:9		
	With SS Frame and Stand		

SMART DISPLAY		Compliance Yes/NO	Remarks
Features	**Minimum Configuration Requirements**		
Scheduler & Designer Software	Browser -Internet Explorer , Safari, Firefox, Chrome		
	OS -Windows 10 Pro 32/64 Bit		
	4GB RAM		
	HDD-500 GB S		
	Multiple schedulers, Time and date based scheduling		
	Web based management		
	Unlimited number of zones		
Thin Client SW License	Thin Client Viewing License		
Main Control PC HW	Intel Dual Core 2.8 GHz, (i5 or i7 series), 8GB RAM, Windows 10 professional or better		
	500 GB HDD, 2 LAN Port , 2 USB		
	Graphics Card - any with Display Port/HDMI or DVI		
Thin Client HW	Intel Dual Core 1.86GHz 4GB DDRII RAM		
	Video -Intel DVMT - 386MB (DVI-D + DVI-I, VGA with Adapter)		
	Audio - Internal 1W Speaker Line Out, Mic In		

1.6 WI-FI HOT SPOT

1.6.1 Specifications of Hardware & Software

WI- FI		Compliance Yes/NO	Remarks
Features	**Minimum Configuration Requirements**		
Hardware Controller	Smart Zone 100 with 4 GigE ports, 90-day temporary access to licenses.		
License	AP management license for SZ-100/vSZ 3.X/SCG200/SZ300, 1 Ruckus AP access point. Order this when you intend to run software version from 3.2 onwards.		
Network Switch	ICX 7150 Compact Switch, 12x 10/100/1000 PoE+ ports, 2x 1G RJ45 uplink-ports, 2x 10G SFP, 124W PoE budget, L3 features (OSPF, VRRP, PIM, PBR)		
Indoor - Wireless Access Point	Indoor Wireless Access Point, 4x4:4 Stream, MU-MIMO, Omnidirectional coverage, 2.4GHz and 5GHz concurrent dual band, Dual 10/100/1000 Ethernet ports, 90-264 Vac, POE in and POE out, Fiber SFP, GPS, IP-67 Outdoor enclosure, -40 to 65C Operating Temperature.		
Outdoor - Wireless Access Point	Outdoor Wireless Access Point, 4x4:4 Stream, MU-MIMO, 120 degree sector coverage, 2.4GHz and 5GHz concurrent dual band, Dual 10/100/1000 Ethernet ports, 90-264 Vac, POE in and POE out, Fiber SFP, GPS, IP-67 Outdoor enclosure, -40 to 65C Operating Temperature.		

1.6.2 Specification & Solutions Features

- Integrated support for multimedia applications such as IPTV and VoFi
- Wired reliability that delivers unprecedented and consistent performance at range
- Share Any Type of Internet Connection
- Safe and Secure Sharing - Hotspot is automatically secured with WPA2-PSK encryption.
- Monitor Network Usage By Device
- Multi-Language and Unicode Support.

1.7 UPS SYSTEM, OFC CABLING & ACCESSORIES

1.7.1 UPS System:

10 KVA On-Line UPS with battery, power backup for 60 minutes. This system required for power backup requirement for Fire Detection Alarm System, CCTV Camera, AV system and Digital Signage (this is for auditorium only). Remaining for CCC & other Units, vendor has to calculate the rating & requirements.

Items	Item Description/ Minimum Specifications
UPS	10- KVA, Sine wave, No. of Battery Supported (12V) -32, Max. Charging Current -5/10/15A, All 3-Phase running appliances, Supported battery - Flat, Tubular, VRLA (SMF), Protection - Current Sensor Fail, DC Low Voltage / Over Voltage, Feedback Fail, High Temperature, Input Phase Reversal, Mains Low / High Cut, Overload, Reverse Polarity, Short-circuit.; Other Features - User Selection switch for Battery Type, Charging Current, Mains input window, System Output Voltage, Mains to Battery Changeover Time,
Battery Rating & Makes	12V/65AH, EXIDE/AMARON/HBL/PANASONIC and Back up: One Hours on Full Load.
Cables & Accessories	Including MS Battery Rack and Interlink Cables & other accessories

1.7.2 OFC Cabling:

Wired connections (Backbone Ring) between all ICT touch points like – CCTV camera, Digital Signage & AV system within rOURkela One complex at ROURKELA.

- 6 Core Single Mode Fiber Cable
- Tube - Thermoplastic Material (PBT)
- Filling jelly - Jelly to prevent Water ingress in loose tube
- Cable - 2 Embedded FRP provides tensile strength & Anti-buckling properties
- FRP - Strength member ensures mechanical protection to fiber
- Outer Sheathing - UV (Ultraviolet) Proof Black Polyethylene
- Rip Cord - Polyester Yarn below sheath for easy ripping

TECHNICAL SPECIFICATIONS OF ELECTRICAL WORKS

1. INTRODUCTION

1.8 The general requirement include design, manufacture, testing at works, supply and delivery at site, unloading and storing the equipment at site, installation, testing and commissioning of the equipment at site of all electrical equipments are covered under this section of the Specification.

1.9 Contractor shall supply the equipment in accordance with the specification, data sheets.

1.10 For uniformity of appearance, all switchgear and control panels shall have a common appearance and colour.

1.11 In order to reduce the spares holding to a minimum, electrical, control and instrumentation components of a similar type and purpose used throughout the Works shall be of the same Manufacturer and type / series unless it can be shown by the Contractor to be impractical.

2. HV FOUR POLE STRUCTURE

The HV Four Pole structure shall be in conformity to WESCO / OPTCL standards with provision of GOD, DO Fuse, Lightning Arrestors, Insulation Disks, Stray Wire, etc. The CONTRACTOR shall provide necessary spare as per WESCO specifications.

All drawings/ documents such as GA drawing of four pole structure showing all equipment mounted on the structure, technical particulars & Bill of Material etc shall be prepared and submitted to Engineer in charge for approval. Obtaining the approval from CEIG/ WESCO and getting power released from supply authority are also included in the scope of work.

3. 33KV RMU

3.1. **Scope**

(i) The scope of this specification comprise of complete design, engineering, manufacture, testing at manufacturer's works, inspection at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site (including transit insurance) and erection, testing, commissioning and performance demonstration of 33 kV VCB enclosed in a close vessel having SF6 as insulating medium along with Load Break Isolator, Earth switch, 33 kV Bus and other associated equipments as per enclosed Single Line Diagram.

(ii) The design materials and manufacture of the equipment shall be of the highest order to ensure continuous and trouble-free service over the years.

(iii) All the ratings, indications, protections, annunciation & accessories indicated in SLD/Datasheet/specifications are minimum requirements & Contractor to provide any additional accessories / components / ratings to suite the actual requirements & for successful commissioning of RMU System.

(iv) Equipment Manufacturer's person shall supervise equipment commissioning activities to be carried out by Contractor's personnel.

(v) All the requirements of this specification are to be considered in conjunction with other sections of the specifications.

3.2. **Applicable Codes and Standards**

(i) The design, material, construction, manufacture, inspection and testing of Switchgear shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. The Equipment shall also conform to the latest applicable standards.

(ii) The Equipment shall conform to the latest standards specified. In case of conflict between the standards and this specification, this specification shall govern.

HV switchgear and control gear-AC Metal Enclosed switchgear and control gear	IEC 62271-1
HV switchgear and control gear-AC Metal Enclosed switchgear and control gear	IEC 62271-200
Circuit Breakers	IS / IEC 62271-100
Disconnectors & Earthing Switches	IEC 62271-102
Metal Enclosed switchgear	IS : 3427 / BSEN:60298 / IEC:298 / IEC 265
Current Transformers	IS : 2705 / BS : 7626 / IEC:60044-1
Voltage Transformers	IS : 3156 / BS : 7625 / IEC: 186 / IEC:60044-2
Arrangement for Switchgear Bus bars, Main Connections and Auxiliary wiring	IS : 5578, 11353
Busbar Support insulators	IS: 2544 / BS : 3297 / IEC : 273
Degree of Protection	IS : 13947 (Part 1) / IEC : 947-1 / IEC : 60529
Electrical Relays for Power system protection	IS : 3231, 3842 / BS : 142 / IEC : 255
Electrical Indicating Instruments	IS : 1248 / BS : 89 / IEC : 51
High Voltage Fuses	IS: 9385 / BS : 2692 / IEC : 282
AC Electricity Meters	IS : 722, 8530 / BS : 5685 / IEC : 145, 211
Specification for copper rods and bars for electrical purposes	IS : 613
Code of practice for phosphating iron and steel	IS : 6005 / BS : 3189
Alternating current Switches for voltages above 1000 V	IS: 9920 / IEC : 129, 265 & 298
Low voltage fuses	IS : 13703 / BS 1362 / IEC 269

Toggle switches	IS : 3452 / BS : 3676
Code of practice for selection, installation and maintenance of switchgear and control gear	IS : 10118
Control switches/ Low voltage switchgear and control gear	IS:6875/BSEN 60947/IEC : 947
HV Cable Termination	IEC 62329
Communication Protocol	IEC 61850
Communication port	RS 485 / RJ 45
High Voltage Test Techniques	IEC 60060
HV switchgear and control gear-AC Switch Fuse combination	IEC 62271-105
Insulation	IEC 600071
Installation	IEC 61936-1
Voltage Detecting Device	IEC 61243-5

(iii) In the event of any conflict between the codes and standards referred to in the specification and the requirement of this specification, latter shall govern.

3.3. **Switchgear / Panel Requirements**

(i) The Configuration of RMU shall be 2 nos. Network Ring switches i.e Load break Isolators and 2 No. 630A Vacuum Circuit Breaker with self-powered protection relay along with BUS VT Metering Panel and separate tariff metering compartment. Self-powered relay will be provided for RMUs (including those in compact substations) with power back up of 3-4hrs. 33/230V Control transformer of suitable rating for RMU auxiliary supply (Lighting, battery charger etc) will be provided.

(ii) Minimum requirements for the switchgear configuration (No. of incomer & outgoing breakers, minimum ratings, protections, indications, annunciations, instruments etc.) shall be as per Single Line Diagrams & this specifications.

Refer following table for Details of RMU requirements.

Sl. No.	DESCRIPTION	RATING	Bidder to Specify
1.	Rated Voltage	33 kV	
2.	Highest System Voltage	36 kV	
3.	Frequency	50 Hz	
4.	Design Ambient Temperature	50 Deg C	
5.	One minute power frequency withstand capacity	70 kV RMS.	
6.	Basic Insulation Level	170 kVp	
7.	Bus bar rating	630A (Ref. SLD)	
8.	Short Circuit Rating	25 kA for 1 Sec	
9.	Insulating Medium	SF6	
10.	Maximum Gas Pressure	0.5 Bar / as per IEC	
11.	Type of breakers	VCB	
12.	Rated operating Sequence	O-3min-CO-3min-CO	
13.	Busbars	Electrolytic Copper	
14.	Temperature Rise	Complying with IEC 62271-1	
15.	Motors	24V DC operated motors shall be installed on the Isolator and CB function and to be flitted in/from the front LV compartment side.	
16.	Power Supply	Power supply to the motors shall be given from the Battery/Battery charger unit / Power pack available in each RMU	
17.	RMU Type	Outdoor Type	

(iii) Outdoor type RMU shall be suitable for installation in severe outdoor environment conditions. Outdoor type RMUs shall have minimum IP 55 protection.

(iv) The degree of protection for RMU tank (Outdoor) shall be IP 67. The mimic board shall be provided with IP2X/ IP3X degree of protection.

(v) The RMU metal parts shall be of high thickness high tensile steel which must be treated with seven tank treatment and subsequently painted with epoxy-based powder paint, the overall paint layer thickness shall not be less than 80 microns DFT.

(vi) All live parts except for the cable connections shall be insulated with SF6 gas. The SF6 enclosure shall be made of welded stainless steel. The gas leakage rate shall be less than 0.1% per annum and no gas filling should be required at site during the product life cycle in normal operating conditions.

(vii) The cubicle shall be metal enclosed with a sheet steel of appropriate thickness and provided with a pressure relief arrangement away from operator and it should be type tested design.

(viii) It is mandatory that complete RMU (gas vessel & cable connection compartment) are required to be internal arc tests for minimum 25kA for 1s for 33kV.

(ix) Any accidental over pressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the rear bottom part of the enclosure. Gas will be release to the rear of the switchgear away from the operator to ensure safety of the operating personnel and all the manual operations will be carried out on the front of the switchboard. The RMU must be tested for IAC FLR to ensure safety of the personnel around the RMU during Internal arc. All manual operations shall be carried out on the front of the RMU.

(x) Internal arc venting by bottom explosion shall be flush mounted on floor; in case of Top explosion the gas coming from the vent should be minimum at 1.62m height which is more than average human height.

(xi) The Entire units of RMU shall be in a single compact metal clad, outdoor/Indoor type (as applicable) suitable for all weather conditions. The SF6 tank must be sealed for life and shall meet the “sealed pressure system” criterion in accordance with the IEC 62271-200 standard. Sealed pressure systems shall be completely assembled, filled and tested in the factory. The RMU must be a system for which no handling of gas is required throughout the 20 years of service life. The maximum leakage rate of SF6 gas shall be lower than 0.1 % of the total initial mass of SF6 gas per annum. The filling pressure for the switchgear shall be just above the atmospheric pressure so as to reduce the tendency to leak. SF6 gas used for the filling of the RMU shall be in accordance with IEC 376. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption. The SF6 insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a simple indication. All the combination of the RMUs should have the required SF6 insulation by providing necessary gas chamber capacity.

(xii) The RMU shall be completed with all connection and contain Copper bus bars with continuous current carrying capacity of 630A at design ambient. The bus bar shall be fully encapsulated by SF6 gas inside the steel tank. There shall be continuity between the metallic parts of the RMU and cables so that there is no electric field pattern in the surrounding air, thereby ensuring the safety of people.

(xiii) Each switchboard shall be identified by an appropriately sized label, which clearly indicates the functional units and their electrical characteristics.

(xiv) The entire switching system shall be totally encapsulated. There shall be no access to exposed conductors.

(xv) All parts of main circuit to which access is required or provided shall be capable of being earthed prior to becoming accessible. This does not apply to removable parts which become accessible after being separated from the switchgear and control gear. The cables shall be earthed by an earth switch with short-circuit making

capacity in compliance with IEC 62271-102. Circuit breaker shall not be closed in case Earth Switch is closed. The earth switch shall be fitted with its own operating mechanism and manual closing shall be driven by a fast-acting mechanism, independent of operator action. Mechanical interlocking systems shall prevent access to the operating shaft to avoid all operator errors such as closing the earth switch when cable is charged. An anti-reflex mechanism on the operating lever shall prevent any attempts to reopen immediately after closing of the switch or earth switch.

(xvi) Every cubicle shall be equipped with a mimic diagram reproducing the single line diagram and with clear indicators to show the position of the switches. The lever operating direction shall be clearly indicated in the mimic diagram. The position indicators shall give a true reflection of the position of the main contacts. They shall be clearly visible to the operator. The Vendor shall provide a marking plate showing RMU's main electrical characteristics.

(xvii) Each panel shall be provided with FPI system mounted on the front panel. Provision to check the synchronization of phases with the use of external device shall be provided.

(xviii) Power supply to the motors shall be given from the Battery/Battery charger unit /Power pack with One (1) Hr backup to take care of the DC load requirements within the RMU.

3.4. **Enclosure**

(i) The enclosure shall be made up of CRCA of 2 mm thickness or galvanized of 1.6 mm thickness, high tensile steel which must be tropicalised to local weather conditions; grit/sand blasted, thermally sprayed with Zinc alloy, phosphate or should follow the 7-tank pre-treatment process and be subsequently Painted with epoxy based powder paint. The overall paint layer thickness shall be not less than 80 microns.

(ii) The metal base shall ensure rigidity for easy transportation and installation.

(iii) The protection degree of the Enclosure shall be IP54 for outdoor type RMU. The enclosure should have two access doors one for the operation and relay monitoring and other for the cable access. The doors shall be provided with proper interlocking arrangement for safety of operator.

(iv) All doors shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. When they are closed, they shall provide the degree of protection specified for the enclosure.

(v) The doors shall open outward at an angle of at least 90 Deg & be equipped with a device able to maintain them in an open position. Ventilation openings if provided, shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained.

(vi) All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequately sized terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry.

(vii) There shall be an arrangement for internal lighting activated by associated switch.

(viii) Labels for warning shall be specified in min three languages including English, Hindi and Local Language. All the labels and manufacturer's operating instructions etc.

shall be durable & clearly legible. They should be located within operating height of the equipment.

3.5. **SF6 Gas**

(i) The SF6 gas shall comply with IEC 376,376A and 376B and shall be suitable in all respects for use in 33 kV panels under the operating conditions. The SF6 shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC 376,376A and 376B and test certificate shall be furnished to the owner indicating all the tests as per IEC 376 for each Lot of SF6 Gas. The stainless steel vessel shall be type tested for pressure test.

3.6. **Load Break Isolators**

(i) The load break isolators for Incoming and Outgoing supply shall be provided and the load break isolators shall be fully insulated by SF6 gas.

(ii) The load break isolators shall consist of 630 Amp fault making/load breaking spring assisted ring switches, each with integral fault making earth switches. The switch shall be naturally interlocked to prevent the main and earth switch being switched 'ON' at the same time. The selection of the main and earth switch is made by a lever on the facia, which is allowed to move only if the main or earth switch is in the off position.

(iii) Closing and opening operation of the Load Break Switch shall be done from local/remote. The load break isolators shall be provided with 24VDC motor to have the facility for remote operation. It should be feasible to retrofit the motor at site.

(iv) Each load break switch shall be of the triple pole, simultaneously operated, non-automatic type with quick break contacts and with integral earthing arrangement. The operating mechanism shall be compatible for remote/SCADA operation.

3.7. **Vacuum Circuit Breaker for Transformer Feeder Control**

(i) The Vacuum circuit breakers shall be of the maintenance free. The Vacuum circuit breaker must be with stored energy spring in combination with 3 positions disconnector with position ON-OFF-EARTH. This disconnector shall be mechanically interlocked with the VCB position & should not be operated when the VCB is in ON condition.

(ii) The circuit breakers shall have at least 2 positions: Open-disconnected and closed and shall be constructed in such a way that natural interlocks prevent all unauthorized operations. They shall be fully mounted and inspected in the factory.

(iii) The Circuit Breaker shall have closing and shunt trip coil. Closing and opening operation of the Circuit Breaker shall be done from remote. Spring charging shall be done with motorized spring operating mechanism. Motor shall be suitable for 24V DC supply. It should be feasible to retrofit the motor at site. The circuit breaker shall be fitted with a mechanical indicator on the panel front facia for indicating VCB ON/OFF positions. It shall be fitted with manual spring charging with a local system for manual tripping by an integrated push button. The operating mechanism shall be compatible for remote/SCADA operation.

(iv) There shall be provision for testing of cable without opening the cable connections. In case cables are to be tested with front door open, doors shall have interlocks such that doors can be opened only with earth switch in closed position. Termination boots

as approved by the Employer's should have a proper opening to facilitate the testing. The opening shall be covered by means of removable protection cap.

(v) The cable compartment cover must be interlocked with the switch position in all the feeders. The cable compartment cover shall open only when the load break isolator / VCB is in earth position. This ensures the complete safety of operator accessing the cables.

(vi) In case of front door opened, it shall not be possible to operate the breaker. All panel covers shall be provided with anti-vandal screw bolts so that opening of panel covers is only possible with special tools, which shall be provided by the Vendor. This is required to prevent pilferage. The cable cover door shall be pad lockable and shall be Tamper and full Arc proof. The circuit breaker and earth switch shall be lockable in the open or closed positions by padlocks. Breaker shall have mechanical endurance of at least 2000 operations.

(vii) An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by an integrated push button. There will be no automatic re-closing.

(viii) The circuit breakers should be able to carry the rated current continuously under site conditions without exceeding the permissible temperature rises for design ambient temperature outside the switchgear cubicle as mentioned in design criteria.

(ix) Following Indications shall be provided for each RMU unit-

- (a) On
- (b) Off
- (c) Trip
- (d) Trip Circuit Healthy
- (e) R / Y / B Indication

3.8. **Relay**

(i) All relays shall be mounted on the switchgear panels.

(ii) All relays shall be numerical relays and have protection O/C & E/F, Trip circuit supervision relay is in built protection in ASHIDA OR C& S make or same make of the RMU manufacturer

(iii) Contact multiplication shall be done by auxiliary relays instead of contactors in case the primary protection relays offered by vendor do not have adequate number of contacts for protection/interlock schemes. Also all necessary auxiliary relays as required to meet the Employer's final control/protection/interlock schemes shall be provided by the Contractor.

(iv) In case the primary protection relays offered by vendor do not have adequate number of contacts for protection/interlock schemes, vendor shall supply suitable contact multiplying auxiliary relays as required. Also all necessary auxiliary relays as required to meet the Employer's final control/protection/interlock schemes shall be provided by the Contractor.

(v) All relays shall be numerical type and shall be supplied with latest version software without any extra cost. It should be possible to set relay, view fault parameters, download information from relay to computer connected for SCADA system. Relays in RMU is communicating on Modbus directly to FRTU and FRTU to SCADA shall communicate on IEC 104. Test terminal block for testing shall be provided.

(vi) Relays shall include necessary auxiliary transformers, A/D & D/A converters, CPU modules for measuring and processing functions, power supply modules with regulator and DC/DC converters and suitable front-end man-machine interface.

(vii) All meters shall be connected through appropriate Protocol as decided by the contractor based on the SCADA requirements.

(viii) Connections of all RS 485 ports shall be done using 3 core twisted & shielded 1.5 sq.mm Cu cable.

(ix) In order to fulfil the requirements of SCADA system, if provisions of additional auxiliary relays are necessary, then the same shall be provided by the contractor at no extra cost to the Employer.

(x) All relays shall have clear identification on the associated panel by well-written inscription plates. Where indications are provided by flag relays or LEDs, these shall also be specifically identified by permanently fixed inscription adjacent to them.

(xi) The relays shall be suitable for application intended. The final relay ranges of each relay shall be decided at detailed engineering stage, if it is found that the offered relay range is not suitable for the intended application, the Contractor shall change the relay of appropriate range without any commercial / delivery implications whatsoever. The relay shall be subject to approval of Employer's representative.

(xii) Contractor shall furnish recommended relay settings with backup calculations. The Employer shall furnish all interface data for this purpose.

(xiii) All relay/ auxiliary relay coils shall operate satisfactorily between 85% to 115% of rated control voltage.

3.9. **Metering Panel**

(i) Separate panel shall be provided for metering.

(ii) Metering panel shall include potential transformer 33/√3/110V/√3/110V/√3, class 0.2, 50VA for 33 kV and tariff meter. Tariff meter shall be communicable type. PT class shall be 0.2 or as per distribution company requirement/statutory requirements whichever is more stringent.

(iii) There shall be no gap between RMU and metering panel.

3.10. **Current Transformers**

(i) Current transformers for metering shall be bar primary cast resin (class of insulation B or better) suitable for operation on 33 kV 50 Hz system.

(ii) Rated VA burden for metering CTs and protection CTs shall not be less than 5VA or 120% of total VA burden whichever is higher.

(iii) The accuracy class for metering CT shall be 0.2s & for Protection CTs it shall be Class 5P20 or as per distribution company requirement / statutory requirements whichever is more stringent.

(iv) It shall be responsibility of contractor to ensure that CT's are suitable for correct and satisfactory operation of relays connected across them.

(v) Short time current rating and momentary withstand rating of CTs shall be as specified in this specification.

(vi) Secondary connection of CT and VT shall be made through disconnecting type terminals with necessary shorting and earthing facility.

3.11. **Bushings and cable terminations**

(i) All the bushings shall be in accordance to the relevant IEC standards, shall be of same height from the ground and protected by a cable cover.

(ii) Each cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming and outgoing cables along with a terminal block (TB) located at convenient accessible location so as to wire all inputs & outputs up to the terminal block (TB). The bushings shall be conveniently located for proper bend so as to allow easy working and termination of cables.

(iii) Bushings shall be conveniently located so as not to interfere with the cable termination.

(iv) Necessary Raychem OR Eq. make dry Right-angle terminal Boots shall be provided with cable testing facility for all the terminations.

(v) Clamping arrangement of suitable insulating material such as HDPE shall be provided to hold the cable.

(vi) Provisions shall be suitable for the HT XLPE insulated, armoured, Aluminium /Cu conductor cables.

(vii) It shall be possible to test the cable without disconnecting them from the cable bushing.

3.12. **Earthing**

(i) The RMU shall be equipped with an earth bus securely fixed along the base of the RMU. The size of earth bus bar shall be to suite SC rating. Provision shall be made on end of RMU for connecting the earth bus to the main earth grid by minimum 2 connections.

3.13. **Voltage Indicator Lamps**

(i) Each feeder shall be equipped with a capacitive voltage detection system (CVD) on the front to indicate whether or not there is voltage in the cables. The capacitive dividers will supply low voltage power to the lamps. These devices shall be in compliance with IEC 61243-5 standard.

3.14. **Fault Passage Indicators (FPI)**

(i) These shall facilitate quick detection of faulty section of line.

(ii) The unit should be self-contained requiring no auxiliary power supply. The FPI shall be integral part of RMU.

(iii) FPI shall be self sustained with SC/EF indications and continues functioning using internal lithium battery even after the main incomer feeder has tripped. It should have an Enhanced Power Management leading more than 2000 hours of operation under fault conditions (blinking).

(iv) FPI should have automatic reset facility through RTU. The FPI must have Configurable Binary Outputs, for remote indication to SCADA for faults/diagnostics via FRTU/RTU.

(v) The FPI shall include;

- (a) Fault detection- Phase to phase and Phase to earth faults.
- (b) One potential free output contact.
- (c) Local fault Indications- LCD display on FPI front panel along with LED indication on front panel of RMU enclosure.
- (d) The FPI should indicate load current on display to understand loading of RMU.
- (e) Multiple Reset option.

(f) End of time delay (adjustable from 1 to 8 hrs).
(g) Remote reset (Via potential free input contact of FPI).
(h) Manual reset (Reset button on front panel of FPI).
(i) Automatic reset on current restoration.

(vi) The Characteristics of the FPIs shall include:
(a) Phase fault thresholds configurable from at least 200 to 1200A.
(b) Earth fault thresholds configurable from at least 10 to 100A.
(c) Multiple number of steps for adjusting phase and earth fault thresholds.
(d) Fault current duration range configurable from at least 40ms to 100ms in 20ms steps and further 100ms to 300ms in 50ms steps.
(e) Variations with respect to above characteristics can be acceptable if vendor/ manufacturer shall provide the same or better flexibility.
(f) RMU should have VCB, FRTU and FPI of the same make of the RMU manufacturer to ensure seamless integration.

3.15. **EMS integration features**

(i) The switches and breakers are to be fitted with motors for remote operation.
(ii) Necessary terminals shall be provided inside the RMU for interface with EMS RTU/Ethernet Switch.
(iii) Following minimum features shall be enabled in EMS -
(a) Remote control for Load Break Switches and circuit breakers
(b) Position indicator for Load Break Switches, Circuit Breakers and Earthing Switches
(c) Remote monitoring and Control of Fault indication system
(d) FPI status and reset
(e) SF6 gas pressure status (indication & annunciation)

(iv) General

(a) Panel illumination lamp shall be 9/11W LED with fixture & shall be provided with door limit switch.
(b) All unused auxiliary contacts of circuit breakers, protection, auxiliary, control relays shall be wired up to terminal block.
(c) Each control wire shall be with identification ferrule of Terminal No., component designation and cross ferruling on both sides.
(d) Insulated sleeves shall be provided for control wires.
(e) Feeder and board name plates to be provided at front and rear of switchboard.
(f) Stud type terminals and ring type lugs shall be used for control cables.
(g) Printed ferrules (tubular type- cut to size after printing) white with black lettering shall be provided. Printing shall be done with the indelible ink.
(h) It shall be entirely the responsibility of the contractor to ensure that characteristics of CTs, VTs and all other devices offered by him are such as to be suitable for the purpose for which they are intended.
(i) AC fail & DC fail annunciation shall be included in the annunciation.
(j) All the wiring shall be able to withstand the tropical weather conditions. All wiring shall be carried out with 1.1kV grade, multi-stranded (Class 5) copper conductor wires with FRLS P.V.C insulation.

(k) All control wiring shall be done with 1.5sqmm size grey colour wires. All CT wiring shall be done with min 2.5sq mm size wires with phase colour coding.

(l) Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals, terminal blocks. The cables shall be uniformly bunched and tied by means of PVC belts and carried in a PVC carrying trough.

(m) The terminal blocks should be stud type for controls and disconnecting link type terminals for CT leads with suitable spring washer and lock nuts.

(n) 20% spare terminals and contacts to be provided for each terminal strip for each panel for future interconnection and interlocks.

(o) Additional red coloured ferrule to be provided for all panels.

(p) Caution name plate, “Caution Live Terminal” shall be provided at all the points where the terminals are likely to remain live and isolation is possible only at remote end i.e. incomer to the switchboard.

(q) Danger notices in three languages (Hindi, English) and in line with the requirements of IS 2551 shall be riveted & not pasted at appropriate locations of the switchgear.

(r) 24V DC supply for protection circuit, motor & indications/annunciations shall be through in-built battery & battery charger system placed in each RMU. Battery shall be sized such that minimum 1 hr. back up is ensured for all operation, protection & indications.

3.16. **Routine Test**

(i) Contractor shall also include cost towards factory testing of switchgear as per IEC 62271-1/200/203/204/100 in presence of Employer’s representative.

(a) Test at factory as follows but not limited to,

- Power frequency high voltage test as per IEC 60060 & IEC 60071.
- DC resistance test as per IEC 60228.
- HV test on control circuit (2kV for 1 minute.)
- CT/PT testing as per IEC 60044. Primary injection test shall be carried out as a part of acceptance test before dispatch of the switchgear panels.
- Operational & interlock test like
  - Close / trip / auto trip operation with electric supply (with given voltage tolerances)
  - Spring charging of motor (Electric as well as manual)
  - Manual close / trip test
  - Closing /opening analysis
  - Interlock & anti pumping operation
  - Checking of filling pressure
  - Checking of gas tightness
  - Checking of partial discharge on individual components

(ii) Contractor shall also assist by carrying all test sets/kit accessories required for site test and also following site tests but not limited to,

(a) Operational & interlock test for open/close operations, tripping, interlocks & anti-pumping.

(b) Insulation resistance test - Megger For 1Min with 2.5/5 kV. (taking value for 10 sec & 60 sec)
(c) Power frequency withstand test
(d) Relay setting as per relay co- ordination and off-line relay testing.
(e) Acceptance testing of individual relays over complete range.
(f) Panel system communication test (For Data Acquisition & Monitoring System only)
(g) Any other tests deemed necessary by the Employer.

(iii) Contractor shall submit his standard format for testing and commissioning of all individual relays and equipment's along with Contractor drawings to be submitted by him to enable proper testing and commissioning at site

3.17. **Type Test**

(i) The Contractor shall furnish type test certificates and descriptive & illustrative technical literature along with all catalogues for circuit breaker, HT panel and other equipment's supplied by him after award of contract.

(ii) The Contractor/supplier shall submit Type Test report (not older than five (5) years) from CPRI or another independent agency for Employer's/ Engineer's review.
(a) Ingress protection test.
(b) Heat run test.
(c) Lightning impulse voltage withstand test.
(d) Short time withstand current
(e) Internal arc withstand
(f) Checking of partial discharge on complete unit

3.18. **Drawings and Data**

(a) Technical Documents to be submitted after award of contract;
- Confirmation to the specifications including Make list.
- Technical GTP as per asked in Data Sheet.
- Descriptive & illustrative technical literature along with all catalogues for circuit breaker, HT panel and other equipment.
- Type test certificates (from CPRI or equivalent agency), not older than five (5) years from the date of submission of this BID for similar rating for the following tests;
  - Short circuit test
  - Internal Arc Test
  - Heat run test
  - Impulse test
  - Endurance test

(b) A matrix of relay model offered with its parameters, Binary/ Analogue I/p – O/ps (IOs), coil voltage, port etc., offered/ considered for each element [with reference to each type of feeder panel (Incomer, Outgoing, Bus coupler, BPT etc.)] for each 33 kV Switchboard.
(c) Tentative GA with dimensions and weight.
(d) Details of sub-contractors, if any.
(e) Other submissions as asked for in the specification.
(f) Any additional enclosure as per Contractor.

3.19. **Documents to be submitted after receipt of Order/LOI for review and Approval.**

(a) All documents under this item shall be provided by Contractor-

- Detail execution plan highlighting the procurement, construction, internal testing, and inspection and delivery activities.
- Quality Plan for procurement, manufacturing and inspection.
- Design Calculations for Bus bar sizing, CT Sizing of all type etc. for each Switchboard along with a copy of relevant standard referred for the same.
- Guaranteed Technical Parameters
- Equipment GA & Section drawings with dimensions, clearances, locations of components- CT, Terminals, etc. of each type of switchboard with component layouts like LV Compartment, etc with general notes.
- Base frame and Foundation GA drawings with dimension and details.
- Electrical Control drawing for all panels with general notes like sizes, type, Material details and other details.
- Catalogue reference, Technical parameters and O&M manual/ write up of all bought out items.
- Test certificates of all bought out components progressively as they are procured.
- Bill of material along with make, quantity, model no and ratings.
- Upon completion of the installation, the Contractor shall furnish a complete set of drawings in soft copies in CDs as per Schedule of Distribution.
- All the Type Test certificates to prove the compliance with the requirements.

4.0. FRTU (FIELD REMOTE TERMINAL UNIT)

4.1. Scope

(i) The FRTU Architecture shall support convenient installation, maintenance and expansion features. Make of FRTU shall be same as that of the RMU manufacturer. It shall have peer to peer communication and with the remote switchgear / EMS at the MSI EMS System through fibre optic cable to initiate the required switching operations. The required no. of I/O modules shall be decided by the Bidder.

4.2. Main Requirements

(i) FRTU cubicle shall be equipped to meet the following main requirements for RMU. It shall be possible to mount it on wall if required.

(a) Monitoring and control of LBS and VCB feeders
(b) Multifunction measurements
(c) Transmit data to the remote control centre.
(d) The system shall have necessary redundancy in communication.
(e) Data storage
(f) Provision for Maintenance
(g) Chronological time stamped event recording.
(h) Data storage in the event of mains failure shall be for at least 8 hours. The minimum storage shall be for about 40000 events.

4.3. Control unit

(i) Control Unit shall perform all the required control and monitoring functions as isolated unit and shall be equipped with a remote and local control mode switch on its front panel.

(ii) Operation in Local Mode:

(i) Transmission of data for remote measurements and time-stamped events shall not be disturbed.

(j) Opening and closing operation after validation.

(k) Inhibition of opening / closing from remote.

(l) Operation in Remote Mode:

(m) Transmission of measurements and time stamped events.

(n) Local electrical control shall get blocked.

(o) Opening and closing operation from remote control centre.

(iii) All data shall be available locally on the front panel of the enclosure and remotely from the control centers. LBS / breaker open and close status can be had from the front mimic of FRTU respectively with the green / red LED indication. It shall be possible to retrieve and display the time-stamped events recorded at the enclosure locally as well as at the remote-control Centre on a lap top computer.

4.4. **Communication with the remote control centre**

(i) FRTU shall have IEC 870-5-101 / 104 protocol to transfer information to control center SCADA and Modbus protocol to communicate with field MFM (Multifunction Meters) on RS485. The Modbus protocol shall be open.

(ii) It shall be possible to configure each measurement to be transmitted spontaneously to the remote control centre with 100% redundancy. Failure of one channel should have an automatic changeover to second channel.

(iii) Data shall be configured using a PC connected to the control unit via an Ethernet and / or USB port. It shall also be possible to configure data remotely.

(iv) Power Supply:

(a) Compact, built in sealed for life 12V battery with a long life and no maintenance of any kind for 5 to 7 years or more along with charger [to be supplied 230 V, 50 Hz from CSS and in case of stand-alone RMU supply arrangements shall be made by Manufacturer] is to be provided in the unit. The supply shall be conditioned to provide power at required voltage for motor operation and communication for local and remote SCADA. The transmission output shall be able to supply a conventional radio [without battery power of RTU] to inform the remote control centre of a battery failure. Power from the unit shall be sufficient to supply control power to all the switch cubicles in the CSS, radio and the electronics in the enclosure. The standby power unit shall be with a minimum autonomy of at least 8 hours for 10 opening and closing cycles. The battery shall be checked at regular intervals by the slave station and an alarm shall be generated and transmitted to the remote control centre in the event of a fault. The unit shall be protected against overvoltage and over loads. There shall be separate batteries for FRTU and Motor Control.

4.5. **Time-tagged data archiving:**

(i) All the archived data shall be retrieved locally and remotely by means of the configuration and operating software supplied with the control unit. The data shall also be downloaded locally or remotely to a PC as a .CSV file.

(ii) Event and measurement time-stamping shall be accurate to one millisecond [ms] and the discrimination between two events shall be 10 ms.

4.6. **Software**

(i) The software shall not require a special license and it can be used and copied freely.

4.7. **Indications**

(i) The slave stations shall process at least the following information for remote indication and for local display purposes:

(a) Open / closed position of each LBS
(b) Earth status
(c) Absence of AC voltage,
(d) Local / remote control operating mode,
(e) Detection of phase-to-phase or earth fault current flow,
(f) Load current measurement
(g) Charger fault
(h) Battery fault
(i) Motor drive DC supply fault
(j) Internal fault
(k) Detailed diagnosis of the status of the uninterruptible power supply (charger, batteries).
(l) Indications for LT side status of switches, alarms as required.

4.8. **Capacity**

(i) The Standard FRTU shall be capable to monitor and control 4 Way / 5 ways RMU.

4.9. **Erection / construction / Operating Tools and Tackles**

(i) Each RMU will be provided with operating lever and other such equipment which are necessary for the normal operation of the equipment. It should also include any spring charging handles for the manual charging of closing springs.

(ii) The tenderer shall separately list out in the tender in the given schedule, sets of tools required for initial erection/construction and subsequent maintenance. The price of those should be included in the cost of equipment.

(iii) An anti-reflex mechanism on the operating lever shall prevent any attempts to reopen immediately after closing of the switch or earthing switch. All manual operations will be carried out on the front of the switchboard.

(iv) The effort exerted on the lever by the operator should not be more than 250 N for the switch and circuit breaker.

(v) The overall dimensions of the RMU shall not be increased due to the use of the operation handle. The operating handle should have two workable positions 180o apart.

4.10. **Testing**

(i) Type Testing:

(a) The FRTU offered by the Bidder shall have passed the required Type tests at Govt. Accredited laboratory in accordance with latest and updated IEC standards. Test certificates for the same shall be submitted along with the Bid.

(ii) Routine Testing:

(a) All tests shall be as per latest IEC standard.

4. TARIFF METER

a) Tariff meter along with the mounting enclosure and all accessories like CTs, terminals, etc., shall be as per distribution company requirement & specifications and should be approved from Distribution Company.

b) The tariff meter shall be located inside the meter room as per DISCOM requirement.

c) BIDDER shall provide necessary separate earth system, as per DISCOM requirement.

d) All required support & structure required for mounting of the above meter enclosure is included in the scope.

5. COMPACT SUBSTATION

SCOPE

All scope for Design, Supply, Installation, Testing and Commissioning of the equipment and systems as specified in this contract/ specification shall be strictly as per specification, rules and regulations; and, not limited to this specifications and guidelines.

The specific scope of this specification for Compact Substation (CSS) covers the following:

Design, engineering and manufacturing; testing at Manufacturer's works, packing, forwarding and delivery to site; unloading and handling (shifting from unloading point to the storage area, storage and shifting from the place of storage to the place of installation) at site, assembly, erection, cleaning & touch up painting, testing, commissioning and performance demonstration at site of Compact Substations of various ratings as specified in this document. Each CSS shall typically consist of the following parts:-

a) Metallic Enclosure with ventilation and rain/ dust protection as appropriate.

b) 33kV VCB

c) 33/0.433kV Dry type transformer of respective rating along with required accessories.

d) LT switchgear

e) Power pack with One (1) Hr backup to take care of the DC load requirements within the CSS.

All the above components of each CSS shall conform to latest relevant standards, codes and requirements.

Civil works for the preparation of equipment foundation, cable trench, and earth pits electrodes, earth grid around CSS and chain link fencing with gate for each CSS is included in the scope of this specification. GA drawings for same shall be submitted by the Contractor.

All SAFETY considerations in design and manufacturing for safe operation & maintenance by Employer personnel and safe practices during installation at site shall be in the scope of the Contractor. Cost towards accomplishing the same shall be included in the BID price and no extra claim shall be entertained later.

Equipments furnished shall be complete in every respect with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specification unless included in the list of exclusions. Materials and component not specifically stated in the specification but which are necessary for commissioning and satisfactory operation unless specifically excluded shall be deemed to be included in the scope of specification and shall be supplied without any extra cost.

All similar standard components/ parts of similar standard equipment provided shall be inter-changeable with one another.

The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

SYSTEM DESCRIPTION

The CSS shall be located in the open space and fenced around for safety and to avoid unauthorized access.

APPLICABLE CODES AND STANDARDS

The design, manufacture and performance of equipment shall comply with latest applicable Codes of Standards IEC 694, IEC 298, IEC 129, IEC 265, IEC 420, IEC 60, IEC 1330, IEC 529, IEC 76, and IEC 439-1.

All components as well as the CSS as a whole shall be Type tested in accordance with the above standards.

CONTRACTOR shall submit the type test certificates of similar equipment within past five year along with the Bid/ after award of contract.

All equipment and material shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard. The main components of compact substation, i.e., HV switchgear, Transformer & LV Switchgear, should be of same make.

Equipment and material confirming to any other standard which ensures equal or better quality may be accepted. In such case copies of English version of the standard adopted shall be submitted.

The electrical installation shall meet the requirement of Indian Electricity Rules as amended upto date; relevant IS code of practice and Indian electricity act.

SPECIFIC REQUIREMENT

Compact Sub-station (CSS) should be a factory-designed, prefabricated substation, tested, ready-to-install and consist of:

(a) Vacuum Circuit Breaker

(b) Distribution Transformer

(c) L.T. Switchgear

CSS can be equipped with the following additional units:

(a) APP type capacitor for no load loss compensation of transformer.

The complete unit shall be installed on a substation plinth (base) as Indoor substation.

The Vacuum Circuit Breaker shall be used to control and isolate the Distribution transformer.

The pre-fabricated unitized substation shall be designed for:

(a) Compactness

(b) Fast installation

(c) Maintenance free operation

(d) Safety for worker/operator & public

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements without any damage or deterioration of the materials.

For continuous operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or datasheet.

SERVICE CONDITIONS:

(a) The equipment offered shall be suitable for continuous satisfactory operation in the area of Installation.

(b) The Enclosure of the Unitized substation shall be designed for normal outdoor service condition and the enclosure construction shall be such that it fully protects ingress of rain water, dust & rusting.

(c) The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

EQUIPMENT SPECIFICATION

All the components of Compact Substation shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IS/ IEC standards.

ENCLOSURE:

(a) The enclosure shall be made of 2.0 mm thickness Galvanized Sheet Steel tropicalised to meet weather conditions including all the partition sheets & doors.

(b) The base of the enclosure shall be of 4.0 mm thickness Hot Dip Galvanized Sheet Steel to ensure rigidity for easy transport & installation. The entire Compact Substation shall be Factory Assembled & Factory Fitted.

(c) The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads. In case of relocation of the Compact Substation, the entire substation should be capable of getting lifted and placed as a Single Unit without dismantling of any of the major equipments inside. The lifting arrangement should be from the bottom of the enclosure & not from the top.

(d) The protection degree of the enclosure shall not be less than IP54 for LT & HT switchgear compartment & IP23 for Transformer compartment.

(e) There shall be proper / adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers and / or apertures shall be provided so that there is circulation of natural air inside the enclosure. The Compact Substation should be designed to have natural cooling & ventilation instead of forced cooling / ventilation as the same would de-rate the transformer further and shall be an additional load on the Transformer.

(f) The complete design shall be compartmentalized.

(g) The connection between transformer and LT switchgear shall be by means of suitable size of Cables / Aluminium busbars. The connection cables to consumer shall be taken out from the L.T. switchgear.

(h) Failure within the unitized substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test to the tune of 25kA for 1 second adhering to the latest IS/ IEC standard.

(i) There shall be arrangement for internal lighting activated by associated switch on doors for HV & LV compartments separately.

(j) Covers & doors shall be a part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90 degrees & be equipped with a device able to maintain them in an open position. Proper padlocking facility shall be provided for doors of each compartment. Transformer compartment doors must be open from both the sides & should not have access from outside.

(k) All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lung arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry.

(l) The components to be connected to the earth system shall include:

- The enclosure of Unitized / prefabricated substation
- The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.
- The metal screen & the high voltage cable earth conductor.
- The transformer tank or metal frame of transformer.
- The base frame
- Enclosure of low voltage switchgear,

(m) Labels for warning, manufacturer's operating instructions, local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

(n) The paints shall be carefully selected to withstand tropical heat & rain, unless otherwise specified. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose powder coating shall be used. Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting. The fabrication process shall ensure that there are no sharp edges on the GI sheets used.

HV SWITCHGEAR

(a) The switchgear should be fixed type, Vacuum circuit breakers with O/C & E/F relay and corresponding auxiliary equipments and accessories.

(b) The Vacuum circuit breaker, Bus bars should be mounted inside a sealed for life, cast resin / stainless steel tank. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front.

(c) The tank should be filled with SF6 gas at an adequate pressure. The degree of protection

for gas tank shall be IP67. There shall be provision for filling the SF6 gas at site. Moreover the Cast Resin / Stainless Steel Gas Tank shall confirm to the sealed pressure system criteria (a system for which no handling of gas is required throughout service life of approximate 20 years) and ensure the gas leakage to 0.1 % per year as per IEC.

(d) It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

(e) The tank shall be totally metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification. The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operations are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools. RMU should be tested for internal arc fault.

(f) Circuit Breaker:
Circuit breaker shall be Vacuum Circuit Breaker (VCB). These shall be triple pole, single throw and suitable for local / remote operation.

Circuit Breaker shall be provided with operating mechanism, self- powered Static relay (Over current & Earth Fault Protection) with associated CTs for control and protection of Distribution Transformer. Relay should have facility to display the maximum loaded phase current also. Relay should also have facility to trip the breaker from remote commands without shunt trip coil.

An integral cable earthing switch with full making capacity shall also be provided with Circuit Breaker. Earthing switches shall be mechanically interlocked with the associated breakers to prevent accidental earthing of live circuit or busbars.

Circuit Breaker shall be provided with the following accessories, unless otherwise specified:

- Mechanical ON/OFF/EARTH Indication
- Mechanical charge/discharge indicator
- Auxiliary contacts 2NO and 2NC
- Tripped on fault indicator
- “Live Cable” LED Indicators through Capacitor Voltage Dividers mounted on the bushings.

(g) Ratings of HV Circuit Breakers, Current Transformers & relay settings shall be selected considering the ambient conditions. The bus bars, Vacuum Circuit Breaker shall have adequate continuous rating as per the requirement and in accordance with relevant IS / IEC standard.

(h) The complete switchgear shall be suitable for breaking capacity as specified in the datasheet and/ or relevant standards.

(i) Busbars shall be of copper and complete with all connections to the switch or breaker. Continuous rating of Copper busbars shall be adequate considering all derating factors. The busbars should be fully encapsulated by SF6 gas inside the tank.

(j) The circuit breaker shall be fitted with static type self-powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable CT’s and Tripping Coil for fault tripping of the Circuit Breakers. CT’s shall be mounted on bushing of breaker. CT’s mounted on cable inside cable compartment are also acceptable.

(k) Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming / outgoing, HT cables. Cable compartment shall be front access, Arc proof and interlocked with the respective earthing switches. From safety point of view, it should not be possible to open the cable box unless the earth switch is ON.

(l) There shall be enough height from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Cable Termination boots shall be supplied by the switchgear manufacturer.

(m) The moving contacts of the earthing switch shall be visible in the closed position through transparent covers.

(n) Suitable padlocking arrangements shall be provided as stated below:

- Circuit Breaker manual operating handle in the “OFF” position.
- Each feeder Panel operating handle in ‘Closed’ ‘Open” or ‘Earth’ position.
- Each isolator operating handle in ‘Closed’, ‘ Open’, or ‘Earth’ position.

(o) VCB
For detailed specification refer respective section of VCB.

TRANSFORMER

(a) Distribution transformer shall be a part of the compact substation which will be housed in the enclosure. The transformer shall be suitable for installation in hot, humid tropical atmosphere. All equipment accessories and wiring shall be provided with tropical finish to prevent fungus growth.

(b) The transformers shall be capable of continuous operation of rated output under the operating conditions of voltage and frequency variations as per statutory limits governed by relevant Indian Standard, Indian Electricity Rules and IEC with latest amendments in force.

(c) The distribution transformer shall be dry type suitable for compact substation housed in an enclosure.

(d) Insulating material shall be of proven design, complying with the requirements of applicable standards.

(e) The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

(f) The magnetic circuit shall be constructed from high grade cold-rolled non- ageing grain oriented silicon steel laminations with non-hygroscopic insulation material on both sides. HV and LV windings shall be of copper.

(g) The maximum temperature rise at the specified maximum continuous output shall not be less than that specified in applicable standards. The transformer shall be suitable for carrying load within the temperature rise.

(h) The transformer shall be provided with following fittings and accessories:

- WTI with alarm & trip contact
- Off circuit Tap changing links

(i) Distribution Transformer
For detailed specification refer respective section of Distribution transformer.

LT SWITCHGEAR

(a) LT switchgear shall be suitable to house following components:

- PVC sleeved Aluminium busbars
- Air circuit breaker (ACB) / Moulded Case Circuit Breaker (MCCB) for outgoing feeder with microprocessor based over current, short circuit and earth fault release.

(b) Bus bar:

Bus bar shall be of high conductivity aluminium supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in BIS. The main bus bars shall have uniform current ratings throughout their length as specified in data sheet. The current rating of the neutral shall be half that of the phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and double spring washers shall be used for all bus bar, joints and supports.

The hot spot temperature of bus bars including joints at design ambient temperature shall not exceed 95ºC for normal operating conditions.
The current rating of the bus bars shall be as required for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably de-rate the nominal rating to suit the above condition.

Interconnections between the main bus bars and individual units shall be made using vertical / horizontal aluminium bus bars of adequate rating.

(c) Air circuit breaker (ACB):
ACBs shall be fixed type with electrically operated (EDO type) spring charging stored energy type mechanism fitted with the microprocessor based over current, Short circuit and Earth fault releases for suitable current rating. 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker shall be clearly indicated.

ACBs shall be provided with the following accessories, unless otherwise specified:

- Indicating lamps to show 'Closed' 'Open', and 'Auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.
- Mechanically operated, red ‘trip’ push button, shrouded to prevent accidental operation.
- Minimum 2 NO and 2 NC potential free auxiliary contacts
- Locking facilities in the 'Service', 'Test', and 'Isolated', positions.
- Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:

  Closing coils - 85% to 110% of rated voltage
  Trip coils - 70% to 110% of rated voltage
- Trip free mechanism/ Anti-pumping protection

(d) Moulded Case Circuit Breakers (MCCBs):

MCCBs shall be of four pole construction arranged for simultaneous four pole manual closing and opening. MCCBs shall be provided with microprocessor based release for incoming and outgoing feeders. Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

For detailed specification refer respective section of LV Switchgear.

CAPACITOR BANKS

(a) Capacitor Bank unit shall be provided on LT side to compensate for the no load distribution transformer losses.

(b) The capacitor bank shall be provided with breakers, ON/Off indications and other associated devices.

(c) APP type capacitor banks shall be provided.

(d) For detailed specification refer respective section of APFC Section.

TESTS

Enclosure shall be type tested for Ingress protection on each compartment.

It is mandatory to have temperature rise test on enclosure for K10 class.

Compact Substation Enclosure and HT switchgear shall be type tested for IAC 25 kA / 1 sec.

Type test reports for enclosure, switchgears, Load Break Switches, Circuit Breakers shall be furnished along with the tender and subsequently.

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out. Type tests shall also be carried out if not tested previously.

Type and routine test report shall be submitted for the EMPLOYER's approval before the equipment is dispatched. Bound copies of test reports shall be furnished along with the switchgear.

All meters and other reference devices used for testing shall have valid calibration from reputed national laboratories/institutes. Inspection by EMPLOYER/ Engineer will not be carried out unless the vendor confirms that calibrated equipment is ready for proceeding with the tests.

Equipment shall not be dispatched unless the test certificates are duly approved by the EMPLOYER/ Engineer-in-charge.

SYSTEM PARTICULARS

a) Nominal System Voltage: 33kV

b) Highest System Voltage: 36kV

c) Frequency: 50Hz ±3%

d) No. Of Phases: 3 Phase

e) Neutral Grounding: Solidly Grounded

f) Fault level: 25kA for 3 Sec

g) Internal Arc withstanding level: 25kA for 1 Sec.

h) Max Ambient Temperature for design and temperature rise shall be 50ºC.

DRAWINGS AND DATA

All Drawings, data, technical particulars, detailed literature, catalogues, type test certificates etc shall be submitted along with the bid/ after award of contract as specified in Bid Document.

6. 33KV VCB

The scope of this specification design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, assistance for testing, installation, commissioning and performance demonstration at site of indoor type 33 kV VCB and its accessories with short time current rating of not less than 25kA for 1sec.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of Metal Clad VCB shall comply with all currently applicable standards, statutes, regulations and safety codes in the locality where the Equipment will be installed. The Equipment shall comply with the latest editions of the Codes and Standards.

The HV Switchgear, Instrument Transformers and other associated accessories shall conform to the latest revisions and amendments thereof, but not limited to, the following standards.

IEC 62271-200 - General requirement for Metal Enclosed Switchgear.

IEC62271-102 - Alternating current Dis-connector (Load break isolators) and earthing switch.

IEC 62271-100 - Specification for alternating current circuit breakers.

IEC 62271-1 - Panel design, SF6/Vacuum Circuit Breakers.

IEC 60044-1/ IS 2705:1992- Current Transformer

IEC 60265 - High voltage switches.

IEC 376 - Filling of SF6 gas in RMU.

IEC 60273/IS :2099 - Characteristics of Indoor & Outdoor post insulators

IEC 60529/IS 13947(Part-1) - Degree of protection provided by enclosures

All codes and standards referred to in this specification shall be understood to be the latest version on the date of offer made by the Bidder unless otherwise indicated.

SYSTEM PARTICULARS

- Nominal System Voltage: 33 kV
- Highest System Voltage: 36 kV
- Frequency: 50Hz ±3%
- No. of Phases: 3 Phase
- Neutral Grounding: Solidly Grounded

- Fault level 25kA for 1 sec
- Internal Arc Tested As per IEC 61641 for 1s
- Max Ambient Temperature for design and temperature rise shall be 50ºC.
- Bus rating: 630A
- Bus bar material: EC grade Copper
- Breaker type: VCB
- Breaker rating: 25 kA for 1 sec
- Protection relay: µP based IDMT relay with 2OC (10%-200%) and 1 EF (10%-40%).

The switchgear shall be metal enclosed, indoor type with vacuum circuit breakers fully draw out type. Design and construction shall be such as to allow extension at either end. Metal enclosed switchgear and control gear cubicles shall be divided into following separate compartments with metal enclosures intended to be earthed (metal clad):

(a) Busbar compartment

(b) Circuit breaker compartment

(c) Cable compartment

All the HV design must ensure conformity to IEC-62271-200 and must be Type tested for Internal Arc Test for 1 sec with AFLR category.

Multi-Function Meter shall be micro-processor based electronic meter and shall have facility for on line monitoring, reading display of each parameter and shall be provided with RS-485 communication port.

The cable glands shall be of double compression type brass glands. Gland plate shall be of 3mm minimum thickness. For Single core cables the Gland plate shall be of Al material.

Gaskets shall be EPDM Type. Hardware shall be stainless steel. Paint shall be two epoxy coats over 2 coats of primer. Epoxy painting may be powder epoxy coated or spray painted epoxy.

20% spare terminals and contacts to be provided for each terminal strip for each panel for future interconnection and interlocks.

Aluminium etched 33 kV Caution boards written in three languages (English, Hindi, Oriya) shall be riveted on the panel as well as on the Doors of the HT compartment. Stickers are not acceptable.

All the routine test as per relevant standards shall be carried out in the presence of Employer / Employer's representative at the Manufacturer's premises. Type test reports shall be sumbitted as per agreed Quality Action Plan.

CURRENT TRANSFORMER

The Current Transformer shall satisfy following requirements:

Current transformers for metering & protection shall be cast resin (class of insulation B or better) suitable for operation on 33 kV, 50 Hz system. The CT ratios/protection class shall be as shown in 'Single Line Diagram'.

Rated VA burden for metering/protection CTs shall not be less than 15VA or 120% of total VA burden whichever is higher.

The accuracy class for metering CT shall be 0.2s or as per distribution company requirement/ statutory requirements whichever is more stringent.

It shall be responsibility of Contractor to ensure that CTs are suitable for correct and satisfactory operation of the instruments/relays connected across them.

Short time current rating and momentary withstand rating of CTs shall be as per breaker SC withstanding capacity.

All CTs shall have secondary rating of 5A.

POTENTIAL TRANSFORMER

The potential transformer shall satisfy following requirements:

Potential transformers for metering/protection shall be suitable for operation on 33 kV, 50 Hz system.

Rated VA burden for metering/protection PTs shall not be less than 50VA or 120% of total VA burden whichever is higher.

The accuracy class for metering PT shall be 0.2 or as per distribution company requirement / statutory requirements whichever is more stringent.

It shall be responsibility of Contractor to ensure that PTs are suitable for correct and satisfactory operation of the instruments connected across them.

MPCB on primary side shall have rupturing capacity equal to the switchgear rating.

For PT's MCB shall be provided on secondary. MCB trip contact to be wired up for annunciation.

EARTHING

The framework and clamping arrangement of breaker shall be suitably earthed internally to the body of enclosure. Separate 2 nos. earthing terminals shall be provided on enclosure for connection to earth grid.

Core shall be earthed to the frame. Suitable arrangement shall be provided for disconnecting the core earthing for insulation measurement.

2 Nos. separate earthing pad / terminals shall be provided on the HV cable box for armour earthing from inside and for owner's grid connection from outside.

Flexible earthing braid shall be provided between all metal parts joined with gaskets.

7. DRY TYPE DISTRIBUTION TRANSFORMER

GENERAL CONSTRUCTIONAL FEATURES

The transformer shall be compact and suitable for easy installation at site. It shall be of modular design; i.e. windings can be individually mounted and replaced on site.

The transformer shall be provided with 4 Nos. Bi-directional cast iron rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

These rollers shall be suitable for being turned through an angle of 90º and locked in that position when the transformer/enclosure is jacked up.

Steel bolts and nuts shall be galvanized.

Transformer shall be suitable for tropical climate & shall be anti-fungal treated. It shall be capable of withstanding thermal effect and stresses caused by short circuit or voltage surges.

Rating and diagram plates of stainless steel shall be provided on LT box of the transformer and shall be easily accessible. Rating and diagram plate shall be riveted to the transformer enclosure at a proper height so that it is readable. The rating diagram plate shall bear details as specified in relevant standards.

Lifting eyes or lugs shall be provided on all parts of the transformer, which require independent handling, during loading, unloading, assembly or dismantling.

CORE

The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain-oriented silicon steel laminations with non-hygroscopic insulation material on both sides. The magnetic circuit shall be of “core type” Construction. The core shall be built up with ‘step-lap' configuration. The grade of laminations shall be low loss type to meet the loss figures specified in the Data Sheet. It shall be carefully interlaced step lap epoxy arranged yoke. It shall be mitred to have low noise and losses.

An adequate painting of resin coat shall cover the complete core and the clamping structure and shall protect it against corrosion.

The Final assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength& prevent vibration during operations.

The core shall be provided with lugs suitable for lifting the complete core & coil assembly.

The core clamping structure designed to minimise eddy current loss & bolts shall not pass through the laminations for any purpose.

The bandages for the core shall be of polyester tape/fiber glass the spacers for clamping the windings shall be of high quality rubber/fiber glass to withstand the temperature rise specified in Data Sheet and the supports shall be of porcelain.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2500V for one minute.

WINDINGS

LV WINDING

a) LV Winding shall be of Copper foil, coated with class F insulation, epoxy resin reinforced with fibre glass layers pre-impregnated and casted under vacuum, to be thermally bound to the winding.
b) The conductors shall be transposed at suitable intervals in order to minimize eddy current and to equalize the distribution of current and temperature along with windings.
c) Insulation of LV winding shall be adequate to withstand surge voltages appearing across them as result of transfer due to an impulse striking on HV terminals.

d) Adequate cooling ducts in epoxy cast shall be provided in the LV winding to obtain the required cooling in axial and radial directions.

e) The resin used for winding insulation shall be non-hygroscopic. It should be possible to energise the transformer without drying even after long period of service interruption.

f) In case of Dyn-11 transformers, neutral shall be brought out in open for solid earthing on secondary side.

g) The winding shall be designed to reduce the out of balance forces in the transformer at all voltage ratios at all operating conditions.

h) The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipments.

HV Winding

a) HV Winding shall be of Copper wire, double layer winding, and cast under vacuum with epoxy resin. The resin shall be pure low viscosity epoxy resin, fiber glass reinforced. The resin cast winding shall be void free.

b) Insulation of HV winding shall be capable of withstanding temperature rise limited to Class 'F'.

c) Resin on winding shall be casted under vacuum and then pressure impregnated. It shall be thermally bound to the winding after initial curing. Casting shall be cured thermally in controlled autoclave with complete cycle and temperature (typically 145˚C for 4-6 hrs.) recommended by manufacturer / standards.

d) The winding shall be designed to reduce to a minimum the out of balance forces in the transformer at all voltage ratios at all operating conditions.

e) The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipments.

f) Adequate cooling ducts in epoxy cast shall be provided in the HV winding to obtain the required cooling in radial and axial directions.

g) HV and LV winding shall be suitably braced and supported at top as well bottom to withstand short circuit stresses set up by surges and damage because of inertia.

h) The resin casting process shall be carried out under the most strict and automated controlled conditions in order to ensure optimum insulating and mechanical properties.

i) The coil finishing shall provide smooth surface eliminating dust accumulation and give effective cooling.

EARTHING

The framework and clamping arrangement of core and coil shall be suitably earthed internally to the body of enclosure. Separate 2 nos. earthing terminals shall be provided on enclosure for connection to EMPLOYER's earth grid.

Core shall be earthed to the frame. Suitable arrangement shall be provided for disconnecting the core earthing for insulation measurement.

2 Nos. separate earthing pad / terminals shall be provided on the HV cable box for armour earthing from inside and for owner's grid connection from outside.

Apart from the neutral leads for power connection, a separate neutral terminal shall be provided to facilitate termination of 2 nos. earthing conductors, which in turn will be connected to two (2) distinct earthing pits by direct connection. The connection may be by insulated cable or by bare strip. In case of cable connection, suitable cable box to terminate the cables shall be provided.

Flexible earthing braid shall be provided between all metal parts joined with gaskets.

Arrangement for supporting 2 runs of GI, up to grade level, from neutral terminal connection installed outside shall be provided.

ELECTRICAL AND PERFORMANCE REQUIREMENTS

Transformers shall operate without injurious heating at the rated KVA at any voltage within + /- 10 percent of the rated voltage of that particular tap.

Transformer shall be capable of delivering rated current at a voltage equal to 105% of rated voltage

Transformers shall be designed for 110% continuous overfluxing with stand capability.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminals, tap changers or other auxiliary equipment shall apply.

Transformer shall be self-extinguishing in the event of fire or arcing and no toxic or corrosive gases shall be released.

There shall not be any risk of cracking of the epoxy casting in the transformer.

Transformer shall have partial discharge level of less than (10pC).

The neutral terminal of windings with star connection shall be designed for the overcurrent this can flow through this winding.

Transformer shall be of low no load loss & low noise.

Transformer shall be certified for following:

a) Class F1 : - “Fire Behaviour”

b) Class C2 : - “Climatic”

c) Class E2 : - “Condensation and humidity”

Vendor to confirm the suitability of the transformer for high inductive loads (high current, short time, unbalance loads).

Transformer shall be suitable for switching with Vacuum Circuit Breakers (VCBs). Resonance frequency of the winding shall be such as to avoid resonance with the switching impulse of VCBs & overstress of the insulation.

The sound level of the transformer shall not exceed the limit indicated by IEC 60076 part-10 standard under any specified operating conditions.

The transformer is intended to operate in parallel with the standby transformer for short period. The transformer shall be designed accordingly.

FITTINGS AND ACCESSORIES

The transformer shall be provided with following fittings and accessories:

- Enclosure with Top cover
- Rating & diagram plate
- Terminal marking plate
- 2 Earthing terminals
- Cable box with HV plug-in connectors
- Bus duct termination arrangement/ cable box for LV side
- Neutral cable box for neutral earthing
- Lifting lugs
- Hauling lugs
- Base Channel
- Under carriage with 4 nos. of Rollers which can be turned 90º and bidirectional.
- High-voltage danger notices against touching of coils.
- Louvers
- Winding Temperature indicator with RTD sensor (minimum 2 per phase) - Pre-set PTC sensors shall be provided and attached to each of the LV winding as close as possible to the hottest spot. The PTC sensors shall be selected in order to protect both, HV and LV windings. Contacts for alarm and trip and shall be suitable for 220V/110V/24V D.C. The Indicators shall have a suitable RS 485 port for transfer of data to plant SCADA/DCS system).
- Marshalling Box
- Off Circuit Tap Changing Links - The tap-changing shall be performed by link mechanism. The links shall be accessible after opening the door/cover. Vendor to indicate the method of tapping from the main winding (braced joint or any other type)
- Cast resin current transformer on transformer neutral for stand-by earth fault protection, Restricted Earth fault protection, as specified in SLD.
- All necessary cable glands, cable lugs, armour earthing clamps, terminal connectors, cable sealing ends and accessories required for termination of the EMPLOYER's cables/ bus duct shall be included.

TESTS

The routine tests shall be carried out as per applicable standards and shall be deemed to be included in the VENDOR'S scope. The following additional points/tests shall also be considered as part of routine tests and included in the scope.

a) Resistance must be measured at extreme taps also in addition to principal tap.

b) Impedance must be measured at extreme steps also in addition to principal tap.

c) No load loss and exciting current shall be measured at rated frequency at 90%, 100% and 110% rated voltage. These tests shall be done after impulse tests if the latter are specified.

d) No load loss and exciting current shall be measured and recorded with 415V, 3-phase, 50 Hz. Input on LV side.

e) Magnetic circuit (Isolation) test as per CBIP.

f) Measurement of zero sequence impedance

Type tests, if required, shall be carried out, as per applicable standards and the VENDOR shall quote extra unit prices for carrying out each of the type test.

In addition, if required, special Tests as listed below shall be carried out as per applicable standards and the VENDOR shall quote extra unit prices for carrying out the same.

a) Partial Discharge test
b) Acoustic Sound Level measurement
c) Short Circuit Test
d) Thermal Shock Test
e) Environmental Test
f) Climate Test
g) Fire Behavior Test

TEST AT SITE

The following tests on dry type transformer shall be performed by the Vendor at site at the time of erection and commissioning. Typical checks to be carried out at site are listed below:

a) Preliminary checks
b) Compare nameplate details with the specifications.
c) Check for any physical damage, in particular of support insulators.
d) Check tightness of all bolts, clamps and connecting terminals.
e) Check cleanliness of support insulators, core coil assembly, marshalling panels, enclosure, etc.
f) Check for clearances.
g) Check earthing of transformer supporting structure/enclosure and neutral terminals.
h) Check that the transformer is correctly installed with reference to its phasing and properly aligned with respect to switchgear and interconnecting external bus duct.
i) Check for proper termination support of HV and control cables, and provision of cable glands for the same.
j) Check for proper alignment and connection of LV side bus bars with switchgear
k) LV bus bars.
l) Check welding/bolting to embedded parts/floor of the building.

Commissioning checks

a) Insulation resistance test of windings and polarisation index on winding.
b) Vector group test.
c) Phase sequence test.
d) Winding resistance test at all taps.
e) Insulation resistance of control wiring.
f) Core loss test at service tap.
g) Voltage/turns ratio at all the taps.
h) Magnetic current balance at full voltage.

i) Capacitance and tan delta measurement.
j) Tests on current transformers
k) Continuity test
l) Polarity test
m) IR tests
n) Magnetization characteristics
o) Ratio test
p) Secondary winding resistance measurement.
q) Measurement of mV drop across HV and LV power connections and joints.

REJECTION

EMPLOYER may reject any transformer if during tests or service any of the following conditions arise:

No load loss exceeds the guaranteed value.

Load loss exceeds the guaranteed value.

Impedance value differs from the guaranteed value by +/-10% or more.

Winding temperature rise exceeds the specified value

Transformer fails on any High voltage tests.

Transformer is proved to have been manufactured not in accordance with the agreed specification.

The EMPLOYER reserves the right to retain the rejected transformer and take it into service until the VENDOR replaces, at no extra cost to EMPLOYER, the defective transformer by a new acceptable transformer.

Alternatively VENDOR shall repair or replace the transformer within a reasonable period to the EMPLOYER's satisfaction at no extra cost to the EMPLOYER.

Also, VENDOR shall repair or replace the transformer in case of transformer failure within five (5) years from date of commissioning, due to any reason including, but not limited to high inrush current, harmonics, switching over- voltages.

SPARES

The VENDOR shall quote item wise prices for the spares recommended for 3 years trouble free operation or as per the agreement between VENDOR and EMPLOYER.

EQUIPMENT PARTICULARS

a) Voltage Ratio: 33/0.433kV
b) Cooling: AN
c) Vector Group: DYn11

d) Tap Changer: +5% to -10% in steps of 2.5%

e) Type of tap Changer: OCTC (Rotary type tap switch)

f) No load current: 1.5% of full load current

g) Max flux density: 1.55T

h) Current density: Max 2.8A/sq mm

i) Losses: As per ECBC

j) Impedance @75ºC As per relevant IS code

k) Clearances: As per relevant standards

l) Current density of the HV & LV windings shall not be more than 1.4A / sq mm.

m) Noise level of transformers shall be as per NEMA standard.

8. LV SANDWICHED BUS DUCT

SCOPE

The scope shall cover design, material, constructional features, manufacture, inspection and testing at the Vendor's/his sub-vendor's work, delivery to site and performance testing of sandwiched metal enclosed bus ducts.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of sandwiched metal enclosed phase bus duct shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

GENERAL

The busbar system shall be of low impedance and sandwiched construction, i.e. no air gap shall exist between bus-bars except at plug-in opening. It shall be possible to mount the busbar in any orientation, without affecting the current rating. The length of each section will be limited to max. 3 m. It shall be totally enclosed pre-painted galvanized steel and be of the non-louvered type maintaining an overall degrees of ingress protection of IP 65(Outdoor) and IP 54 / 55 (Indoor).

BUS BARS

Busbars shall be of Aluminum with conductivity >60%. Neutral shall be 100% of cross sectional area of the phase conductor. A continuous earth busbar (Internal/External) shall be provided. Flexible connections shall be provided with Cu braided / multi leafed conductors for termination at both the ends. The busbars shall be individually insulated with by minimum 2 layers of insulating film. Bus bar conductors shall be insulated with insulation Class F material. All the insulation materials shall be halogen free and fire retardant.

HOUSING

The busbar housing shall be non-ventilated. The enclosure shall be of hot dip galvanized and pre-painted sheet steel. The housing shall be made of minimum 1.6 mm electro galvanized sheet steel, with an epoxy powder coated paint finish. It shall pass at least 1000 hours salt spray test to

ensure the anticorrosion ability. The housings shall be profiled, to provide higher strength and efficient heat dissipation. The width of the housings shall be preferably the same for all ratings of busbars, in order to provide interchangeability of tap off boxes. Inspection cover shall be provided over joints to inspect the tightness of the connection.

JOINTS

The electrical joints shall be of one to four bolt type designed for even distribution of contact pressure. Bolts shall be accessible without removing covers. The joints shall be so designed as to allow removal of any length without disturbing adjacent lengths. The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the Uniblock Joint. The joint construction must have the following features.

a) Shear off nut : To ensure tightness of joint at desired torque

b) Tamper proof cap over shear off nut to prevent opening of nut after achieving desired torque.

c) Heat expansion of atleast 3 mm per joint.

d) The joint insulation must be of one piece mould design and not have any cut edges which can absorb moisture.

e) Joint assembly shall be removable as separate sub-assembly so that it can be inserted or removed without disturbing the adjacent sections.

f) The busbars ends shall not have any holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.

EXPANSION JOINT

Busbar expansion units shall be used in cases to reduce the stress on the system by differential expansion between the busbars and the casing; particularly for long run of the busbar. It shall consist of a flexible joint in the middle on the conductors and a sliding casing in 2 sections which can absorb the relative movements of each section of the length.

ACCESSORIES

The bus system shall be complete with all the accessories such as straight run lengths, bends/elbows / flat elbow/ edge elbow/ T sections, vertical anchors, expansion joints, flexible connections, flange ends, reducer, end covers etc. All the accessories as required to suit site conditions are deemed to be included in straight length of the bus trunk.

Flanged end boxes shall be provided to accommodate flange end for connecting the bus terminating with flanges of panels, transformers & DG sets etc. At every terminal point at flanges the connection shall be done using flexible connections.

Any other item/ accessory not specifically mentioned above but deemed necessary by the bidder for successful implementation

WALL FRAME ASSEMBLY AND SEAL OFF BUSHINGS

Wall Frame Assembly

Wherever the bus duct passes through the plant building wall, from indoors to outdoors, a wall frame assembly with seal-off bushings shall be provided to prevent any leakage of rain water, infiltration of dust and air temperature variations from indoors to outdoors. The wall frame shall be fabricated out of aluminium angles and sheet and shall be suitable for grouting in the wall.

End cable tap box

End cable tap boxes shall be applied to feed a run of bus duct with cable and conduit. The enclosure shall be designed to accommodate specified size and number of cables per phase. Conductors are separated and provided with the required number of cable lugs per phase, and necessary space for cable termination. The enclosure shall be provided with removable access covers as necessary for access to power cable terminations.

Phase Transposition

Phase transposition is normally provided within the switchgear equipment. However, when required, it can be provided within the bus run system to align phasing of terminal equipment at two ends.

BUS DUCT SUPPORTS

The supporting structure shall be fabricated from standard steel sections and shall be hot dipped galvanised after fabrication. Calculations shall be furnished to substantiate the strength of support structure shall withstand various static and dynamic loadings. The supporting structures shall include supporting members, brackets, hangers, longitudinal beams, channels, nuts, bolts, washers and all other hardware which are necessary for the erection and support of the entire bus duct installation. All the accessories and hardware of ferrous material shall be hot dip galvanised.

Indoor portion of the bus duct may be supported from the floor or ceiling beams. Outdoor portion of the bus duct shall be supported from ground below on suitable foundation in the ground & on the wall with either embedded plates or anchor bolts wherever required. The foundations and structures in outdoor area shall clear the transformers, transformer foundations, cable trenches, CSS.

EARTHING

A separately run earthing flat suitably clamped along the enclosure shall be used as the ground bus. Conductor material and size shall be calculated during detailed design engineering by the Contractor. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to above ground bus. Ground pad shall be bolted type to accommodate the required size galvanized steel flats. Complete with suitable tapped holes, bolts and washers

TESTS

All routine tests as specified in IS/IEC shall be conducted at the works and all site tests shall be conducted as per IS/IEC at site after the complete bus bar is assembled.

Certified copies of reports/certificates with final conclusions of type tests carried out as per relevant standards on similar type and rating of the equipment within last five years shall be

furnished for review along with the Bid. In case the type test reports are not found to be meeting the specification requirements or older than five years, then the VENDOR shall conduct all such tests free of cost and submit the reports for approval without any cost and time implication to the PURCHASER

Type test assembly shall comprise of all the major components such as Insulations, joints, Tap-off units, etc., and shall depict the actual site installation. The components used in the type test assembly shall not be used in the bus bar sections being supplied for the project.

The busbars shall be type tested at a reputed national / International test laboratory (ASTA / KEMA or CPRI) for short circuit withstand. The test shall be for a minimum duration of one second.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for Min IP54 for indoor and Min IP 65 for Outdoor application.

TYPE TESTS

The Bidder shall furnish type test certificate for the following tests conducted on similar equipment as per IEC 61439

a) Temperature Rise Limits (for each rating)

b) Dielectric Properties

c) Short Circuit Strength

d) Degree of Protection

ROUTINE TESTS

Following routine tests shall be conducted on the Bus trunking.

a) Physical verification check

b) Megger Test

c) Power frequency with stand test

d) Any other tests as stipulated by the relevant standards

TECHNICAL DATASHEET

SL. NO.	ITEM	UNIT	
1.0	**General**		
1.1	Bus Bar arrangement		Sandwich
1.2	Bus Bar configuration		3phase + 100% Neutral
1.3	Phase		3

SL. NO.	ITEM	UNIT	
1.4	Neutral		100%
1.5	Rated operational voltage	V	1000
1.6	Rated insulation voltage	V	1000
1.7	Rated Dielectric voltage	kV in r.m.s	3.5
1.8	Rated impulse withstand voltage	kV	12
1.9	Rated frequency	Hz	50
1.10	Degree of protection		Min IP54 for Indoor Min IP 65 for outdoor
2.0	**Bus Bar**		
2.1	Bus Bar Ratings	A	To be calculated
2.2	Short circuit rating	kA	To be calculated
2.3	Bus Bar material (Phase / Neutral)		Aluminium
2.4	Bus Bar material (Internal earth bus bar)		GI
2.5	Bus Bar material (External earth)		GI
2.6	Bus Bar insulation		Minimum 2 layers of insulating film Class F
2.7	Fire rating		240 min (ISO 834)
2.8	Joint type		Uni-block Joint
3.0	**Bus enclosure**		
3.1	Enclosure material		Hot dip galvanized sheet steel
3.2	Surface coating on enclosure		Epoxy powder coated paint
3.3	Paint		As per engineer-in-charge
4.0	**End Feed unit/Central Unit**		
4.1	End Feed unit Required	Yes/No	Yes
4.2	End Feed unit rating	A	As per requirement

SL. NO.	ITEM	UNIT	
4.3	Centre Unit Required	Yes/No	As per requirement
4.4	Centre Unit rating`	A	As per requirement
5.0	**Tap off Units**		
5.1	Tap off unit Required	Yes/No	No
5.2	Tap off unit Qty. and rating	A	As per Requirement
5.3	Tap off unit type		-
6.0	**Terminations**		
6.1	Flanged End Terminations required	Yes/No	Yes
6.2	Cu Flexible Connections required	Yes/No	Yes

9. L V PANELS

The scope of supply covers design, manufacture, testing and supply of LT Panels.

LT panel shall be (tested assembly - TTA) CPRI /Independent international test house tested for all the tests as per IEC61439-1 & 2 and internal arc tests as per IEC 61641 V3, at Fault level (to be determined by the Bidder) for 0.3 sec minimum at Horizontal bus bar, vertical bus bar and cable chamber.

LT Panel shall also be tested of design as per Seismic Zone II of IEC 60068-3-3.

Panel shall be rated for Impulse withstanding capability equal to or greater than the switchgears inside the panel.

The metal enclosed switchgear shall be designed to operate continuously with reference of ambient temperature of 50ºC without any de-ration.

The equipment shall be designed and manufactured in accordance with the best engineering practice and shall be such that has been proved to be suitable for the intended purpose.

Provision for interlocking of LV Incomer breaker with HV side breaker shall be provided such that if the HV breaker trips then the LV breaker will trip and it shall not be possible to close the LV breaker unless the HV side breaker is closed.

The Panel shall be indoor type having incoming sectionalisation and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 52 for indoor up to 2500A rating and IP42 above 2500A rating and IP55 for outdoor as per IS: 13947 (Part-I).

All panels shall be from same manufacturer.

LV panel manufacturer must have experience in manufacturing, supply and installation of LT panels of TTA or IEC 61439 designed during the past 7 (seven) years as a qualifying requirement.

CONSTRUCTIONAL REQUIREMENTS:

All panel boards shall be free standing, metal enclosed, single front, fabricated with 2mm CRCA sheet steel for all doors, partitions and covers and 2 mm CRCA sheet steel for load bearing sections including all ACB feeders. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. The Bidder shall confirm the base channel size requirement.

The gasket shall be suitable to withstand all weathers for long tenure of service. All hardware shall be HD Galvanized or stainless steel.

PCC, APFC, DG Synchronising / AMF panels shall conform to FORM 4B as per IS 61439 and metering, common services, street lighting panels shall conform to FORM 3B as per IS 61439.

For operator safety IP2 X (touch proof) protection to be available even after opening the feeder compartment door. The compartmentalization shall be achieved by using metal separators.

Each door & cover shall have adequate reinforcement of suitable ribs & stiffeners. All such door shall open at min 105^{o}. All feeders and cable alleys shall have hinged type door with panel locks. All bus-bar covers and other panel covers shall be screw fixed. Cable alleys and bus-bar chamber shall have minimum width of 300mm.

All doors shall be with concealed type hinges and captive screws. Rear doors of panels requiring rear access shall be provided with removable hinged doors. Side covers of panels shall be with removable panels.

All doors shall be provided with durable and easy fitting locks with special keys to ensure opening by authorized personnel. Rubber grommets shall be provided at the cable entry.

All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the vendor.

All the panels shall have uniform height. The operating height of all the panels shall not be less than 300mm and not more than 1900mm. Panel height should not be more than 2450mm.

All the panel boards shall have cable entry from bottom. Split gland plate of 2mm thick shall be supplied for termination of power, control and instrumentation cables sized as per the required no. of cable and 20% spare space for future addition.

<u>BUS-BARS:</u>

a) Bus-bar of the panels shall be rated for Continuous current at site conditions.

b) All bus-bars shall be electrolytic grade copper or aluminium. BIDDER shall specify the purity and conductivity of the bus bar along with the BID.

c) All the bus bars shall be sleeved with heat shrinkable black colour PVC sleeve or better insulation with coloured polyester tapes for phase identification at regular intervals/ locations.

d) BIDDER shall submit all calculations & documental proof of the adequacy of the bus bar sizes to meet the continuous and short time current ratings specified for reference during procurement/ manufacturing.

e) Vertical bus-bars shall have S.C. rating same as main bus bar and shall be suitable for all connected load of vertical section.

f) BIDDER shall ensure that incoming feeder shall be suitably designed for terminating the required no. of runs of 1.1kV grade XLPE insulated armoured cables with 20% spare capacity. BIDDER shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the cables within the limits specified above.

g) The bus-bars shall be designed considering the following criteria:

- Current density of 0.8A/sq mm maximum for aluminium and 1.6A/sq mm for copper.
- Sleeves made of insulating material on all bus bars.
- Bus bars carrying rated current continuously at Design Ambient Temperature shall be considered as 50ºC and temperature rise shall be considered as per latest relevant standard.
- Configuration of bus bars and Proximity effect
- Bus bars shall withstand the short time rating of the panel.

h) The span between the two insulators shall be as per the approved TYPE TEST REPORT for short time rating. Joint positions and insulators shall be properly adjusted so that they don't interfere. Bus bar bending shall be carried out on appropriate machines designated for the same rather than doing manually.

i) Neutral bus-bars of the panel boards shall be rated equal to the size of phase bus and shall be in the same chamber with phase bus bars.

j) All bus-bar shall be treated with anti-oxide paste wherever bi-metallic contact is required.

k) The material and spacing of the busbar support should be same as per the type tested assembly.

EARTHING:

a) Earth bus bars of Aluminium material shall be run all along the panel, extended out at both ends of value equal to the rated symmetrical short circuit rating of the associated switchboard/ panel. The same shall be properly supported to withstand stresses induced by the rated symmetrical short circuit current.

b) Earthing bus-bar shall be terminated at both ends of the switchgear to suit the connections to earthing conductor. The locations where the bus are protruding out of the panel boards, CONTRACTOR shall ensure that proper ingress protections are provided at all such locations.

c) All doors and detachable components inside the feeder are required to be earthed individually with green (with yellow band) colour PVC insulated multi stranded copper conductor wire of size 4 sq.mm duly crimped with ring type lugs and are to be looped & connected to horizontal earth bus.

d) Earthing bus shall be run continuously in panel drawn out suitably considering respective cable entry inside the panel.

e) Separate Al earth bus shall be provided at each cable alley for all the panels.

POWER WIRING (INSIDE THE FEEDER):

a) All power wiring for rating upto and including 63A shall be carried out with 1.1kV grade coloured HFFR/ FRLS PVC insulated, coloured for phase identification, multi stranded copper wires duly crimped with ring type lugs.

CONTROL WIRING (FOR PANEL AND FEEDERS):

a) All panel Control wiring shall be done by 1.1kV grade HFFR/FRLS PVC insulated multi-stranded copper wire. CT circuit wiring shall be done with minimum 2.5 Sq.mm size wire of above specification. Control and Potential circuits shall be wired with minimum 1.5 sq. mm

size wires of above specifications. Wires shall be gray coloured with suitable crimp able copper lugs. CT's & PT's wiring shall be colour coded for multi-phase identifications (R-Y-B-N).

GENERAL REQUIREMENTS:

a) DP MCB shall be provided for all control circuits where the fault level is less than 10kA. Else the control supply shall be tapped through a control transformer of adequate capacity supplied with MCCB/ MPCB/ SFU of adequate short time rating. Independent DP MCBs shall be provided for each circuit such that tripping due to fault in one circuit should not affect other functions adversely.

b) Self explanatory Wiring diagrams with terminal and wire numbers, component numbers shall be provided on the inner face of the door of each feeder. Drawing set in the panel shall be laminated.

c) All labels for identification of feeders as well as internal and external components as per legends provided By EMPLOYER shall be on white acrylic sheet with black engraving. These labels shall be fixed by screws/rivets and shall not be pasted.

d) Aluminium etched 415V Caution boards written in two languages (English, Hindi) shall be riveted on the panel at locations where live bus bars are present and need isolation before any access to it. In case secondary covers have been provided inside the panel, then caution boards shall be also marked on these boards in addition to the external covers. Stickers are not acceptable.

e) Selector/control switches shall have an 'Off' position. The 'Off' position shall not be wired in any circuit and shall be utilised to disconnect (or bypass) power supply to control circuit for any maintenance work.

f) All electrical panels (internal components & arrangement) shall have finger touch protection, for human safety viz. working on one component shall not cause shock to the personnel due to any other live component in the panel. Also, the terminal live parts shall not be accessible by fingers (finger cannot come in contact with live parts of the terminals).

g) No openings/ holes meant for fixing hardware shall be left open. All the hardware (esp. screws, nuts, bolts, and washers) shall be in all appropriate positions & properly tightened.

h) Phase separators, shrouds, falling tool barriers shall be suitably provided. Any additional requirements as observed at any stage upto handing-over shall be provided (for safety and ease of maintenance) without any cost implication to the EMPLOYER.

i) All PVC/engineering plastic based items (including but not limited to conduits, casing-capping, trough, trunk, enclosures, covers, plugs, etc) shall be with FR properties.

j) Lifting hooks/eyes shall be provided in each shipping section of the equipment and shall be removable type. The equipment shall be given tropical and fungicidal treatment.

k) Insulation mat of suitable standard width shall be provided in front of the HV and LV panels.

l) Atleast one 230V, 1Ph, Space heater shall be provided for each vertical section of the switchboard. Each Space heater shall be provided with an isolating switch, a thermostat and dedicated MCB protection of appropriate rating. Heater shall be mounted at bottom of the panel with cover to avoid accidental contact of heater with skin.

m) 230V 1Ph, Panel illumination (11W CFL/ LED fixture with lamp, limit switch and isolation switch) along with 1 no. 5/15A 5 pin socket with switch shall be provided for each vertical section. Bare holder with open lamp is not acceptable.

n) Adequate space shall be provided for terminating the outgoing cables.

EQUIPMENT REQUIREMENT:

a) MCCB:

- All the panels shall have MCCBs upto 630Amp. All MCCBs shall be rated for 415V, 3 Ph, 50Hz.
- All MCCB shall be microprocessor based. MCCB shall have O/C, S/C Protection. Wherever MCCBs are used as incomer these shall be provided with earth fault & time delay or as specified in SLD. MCCBs of suitable Icu=Ics=100% ratings.
- There should be earth fault indication on panel door.
- Rated operational voltage will be 415V AC with +/-10% variation.
- All MCCBs shall be with Utilisation Category "A".
- All the MCCBs shall invariably be Current Limiting type, features like Double Break, Positive Isolation functions shall be Integral feature of the device and shall provide a cut off in, < 10 ms for prospective currents during faults. All MCCBs shall be provided with rotary handle with door interlock and extension links/ spreaders with proper shrouds. No live part accessible even after opening the front cover.

b) ACB:

- From 800 A onwards ACBs shall normally be used. These should have 50 kA (Icu=Ics=Icw) Short Circuit Current rating with microprocessor based overload, short circuit and earth fault protection at 415 volts, 50 Hz.
- The air circuit-breakers (ACBs) used in low-voltage installations shall be designed, built and tested in compliance with the standards of the IEC 60947-2 & EN 60947/ IS 19947 (Part-II) : 1993.
- Rated operational voltage Ue should be 690 V.
- The rated insulation voltage shall be equal to or greater than 1000 V.
- Overload protection shall have adjustable setting from 50% to 100% of the ACB's rating.
- The ACB release shall be self-powered, requiring no external power supply. For it to operate, it is sufficient for one phase to be loaded at 20% of the rated current of the current transformer.
- Power loss in breakers should also be watched for selection.
- Utilization category-B
- Releases are also available with LCD display which displays all three phase current & neutral current, running voltage, average voltage and maximum voltage. These releases will also display maintenance date like no. of operations, & fault history (last 10 trips and type of fault). To protect the load and cables from repetitive over temperature protection. In case of BMS connectivity through Ethernet communication, the release shall enable the user ON, OFF, Trip status communication.
- Individual fault indication LED's (OL,SC & EF) backed by lithium battery to give indications even when the CB is off and electrical fault trip (OL& SC) alarm indication on panel shall be available on trip units for easy & faster identification of cause of fault.
- ACB with microprocessor based trip release with adjustable (O/C, S/C & E/F Protection) with adjustable current & time delay & %loading bar graph for each phase.
- For Distinct Fault Indication, required voltage supply shall be derived from the existing control supply by BIDDER. No separate charges shall be asked for later during execution.
- All instrument transformers shall be cast resin type and shall have insulation of class B or better.
- Indicating lamps shall be of the Multi chip LED type with low watt consumption.
- Each incomer shall be provided with a Multi-Function Meter displaying all electrical parameters like (but not limited to) current, voltage, kW, kVA, KVAr, kWH, MD, PF, Hz, (THD measurement only in main PCC incomer) etc. and shall have provision for remote communication with SCADA/ BMS..
- The switchgear shall be complete with all equipment such as CT, VT, switches etc. duly wired up to terminal blocks. Terminal blocks shall be located at suitable place for easy access. CT shorting, isolating terminals shall be provided for CTs and isolating terminals shall be provided

for VT connections. Twenty (20) percent spare terminals shall be provided in each cubicle. Ring type lugs suitable for termination of 2.5 sq mm copper wires shall be used.

10. HPFC PANELS

Scope comprises of Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of HPFC (hybrid power factor correction) panel having IGBTs, microprocessors, capacitors, reactors and other associated accessories, as explained below.

The system shall be designed as per IS 16636. The degree of protection of enclosures system shall be IP42 in accordance with IEC 60529.

The HPFC panel shall be controlled through a single integrated controller for both Active and Passive part.

Operation Philosophy:

Active Harmonic Filters (AHF) shall employ digital logic and IGBT semiconductors to synthesize a current waveform that is injected into the electrical network to cancel harmonic currents caused by nonlinear loads. The AHF shall employ a current transformer to measure the load current to determine the content of harmonic current present. By injecting the synthesized current, network harmonic currents shall be greatly mitigated, thus reducing the heating effects of harmonic current and reducing voltage distortion.

The harmonic filtering equipment shall also be able to correct either leading (capacitive) or lagging (reactive) power factors as well. The AHF shall also have the ability to correct displacement power factor (DPF) and mains current balancing. DPF correction can be provided for either leading (capacitive) or lagging (inductive) loads that cause poor DPF. Mains current balancing shall be achieved by measuring the negative sequence current present and injecting the inverse negative sequence current to balance the current for the upstream network.

The Passive Correction device (capacitor bank) shall work on the principle of measurement network power factor and shall switch on required number of capacitor bank stages (through a PF Controller) to improve the power factor of the electrical network.

The contractor has to submit software simulations indicating that the Total Demand Distortion (TDD) is less than 5%. The Total Harmonic Distortion Voltage (THD V) shall be within the limits as specified in IEEE Std 519-2014 (Standards on IEEE recommended practices and requirements for Harmonic Control in Electric Power System). The point of common coupling (PCC) for such calculations shall be at the transformer incomer secondary (415 V Supply). The simulation software should take into consideration the performance of the de-tuned capacitor bank. The Passive Correction device shall not amplify the existing system harmonics.

To ensure safety, reliability and accountability of component coordination, all the major components such as Active Filters, Capacitor units, De tuning reactors, PF controllers, Circuit breakers, Contactors and the Enclosure system called for in this specification should preferably be from a single manufacturer.

The HPFC panel shall, in its default configuration, shall implement the following:

- Step-less Power Factor Correction (for both leading and lagging current)
- Harmonics Compensation up to 51st order (2nd priority)

- Load Current Balancing in the three phases (3rd priority)
- Neutral compensation

The HPFC panel shall comprise:

1. Incomer
    i. A suitable sized four pole ACB/MCCB having microprocessor based over-current and short-circuit protection and at least 36kA breaking capacity (Ics) as the incomer of the panel. The breaker shall be selected considering 1.5 times the full load current carrying capacity. Refer the breaker section in the LT Panel specifications for details.
2. Metering and Indication
    i. HMI display meter showing voltage, current, frequency, PF, THD, kW, kVA, and other related parameters shall be provisioned
    ii. Required number of CTs of suitable rating shall be provisioned
    iii. Required number of three phase digital ammeter showing current of HPFC panel shall be provided
3. An active filter part and a passive filter part; the ratio of the rating of active filter to that of the passive filter shall be at least 1:1. The exact distribution of total capacity between the active and passive part shall depend on the rating of the HPFC panel.
4. Specific number of fixed detuned capacitor banks
    Each fixed detuned capacitor bank unit shall comprise:
    i. Incomer
        a. A suitable sized three pole, microprocessor based MCCB having over-current and short-circuit protection and at least 36kA breaking capacity as the incomer. 100% Icu breakers shall be used.
        b. Contactor switching module of required rating.
    ii. Power Circuit
        a. One unit of three phase delta connected capacitors of suitable rating
        The capacitor unit shall be heavy-duty APP type and have an AC voltage rating of 525V
        b. A series detuned reactor of suitable rating connected to the capacitor bank
        The series detuned reactor shall be a 14% copper reactor having linearity of at least 180%
        c. Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation from the reactors and capacitors shall be provided
    iii. Control Circuit
        a. On and Off indication lights for each detuned capacitor bank

b. Start and Stop push buttons for each detuned capacitor bank
c. Auto/Manual selector switch for auto mode (through the HPFC Panel's DSP microprocessor) or manual mode of operation of the capacitor banks
d. On delay timer for the detuned capacitor bank so that all the detuned banks don't get switched on at the same time

5. Specific number Active filter unit of suitable rating

Active filter unit shall provide the required reactive power in a step-less mode to meet the requirement for power factor correction, harmonic compensation and load balancing Each Active filter unit shall comprise:

i. Incomer
   a. A suitable sized three pole MCCB having microprocessor based over-current and short-circuit protection and at least 36kA breaking capacity (Ics) as the incomer of the 3Ph HPFC Panel
      100% Icu breakers shall be used
ii. Metering and Indication
   a. On/Off selector switch for the Active filter
iii. Power Circuit
   a. A suitably sized three phase inverter stack. Alternatively, the 3Ph inverter stack may be replaced with equivalent number of single-phase inverter stacks depending on the rating of the active filter
      The inverter stack shall be rated for the full rating of active filter and shall have sufficient margins for overloading the filter
   b. Three single phase inductor chokes of suitable rating
      Inductor chokes shall have overload margin of at least 150% for 1 minute
   c. A suitable sized three pole AC3 duty power contactor
      The contactor shall be connected to the input of the IGBT power stack
   d. The inverter stack shall comprise suitable number and rating (with sufficient margin for overload) of IGBTs, DC Capacitors and IGBT driver circuits to meet the full power output of the inverter stack
   e. Resistors, capacitors and other passive components of suitable rating (with sufficient margin) and quantity to continuously carry the full load of the filter
   f. Cables, bus-bars and other associated hardware of suitable rating (with sufficient margin) to continuously carry the full load of the filter
   g. Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation from the inverter stacks and inductor choke shall be provided

h. Heavy duty PWM filter comprising capacitors, resistances and/or inductors to filter out the switching ripple from the filter output

iv. Control Circuit

a. Control MCB of rating 6A-FP-10kA-C Curve to provide power supply to the control circuit of the Active filter

b. Advanced DSP microprocessor controller which shall monitor the voltage and current in the three phases (Red, Yellow and Blue) to compute the exact power requirement in the three phases, and thus, implement the following features - step-less compensation of leading and lagging power factor, harmonics compensation and load balancing

c. Suitable number and rating of voltage and current sensing circuits

d. Necessary control and firing cards with proper wiring and lugs of required rating shall be provided

e. Suitable number and rating of any other items, e.g. relays, SMPS, etc.

6. The HMI (human machine interface) installed in the HPFC Panel shall have the following features:

a. A 7-inch, colored touchscreen LCD interface

b. It must at-least have Ethernet port, USB port and SD card port

c. It must support MODBUS TCP communication protocol

d. Start, stop and trip status (with trip code) on the home screen

e. Internal CAN communication with the DSP controller

f. The HMI must display the following (minimum) numerical parameters

i. Arms - All 3 phase currents + Neutral

ii. A1rms (Fundamental Current) - All 3 phase fundamental currents

iii. iTHD (%) - All 3 phase current harmonic distortion

iv. Aunb (%) - All 3 phase current unbalance

v. Vrms - All 3 phase voltages

vi. Urms - All 3 line voltages

vii. V1rms (Fundamental Voltage) - All 3 phase fundamental voltages

viii. vTHD (%) - All 3 phases voltage harmonic distortion

ix. Vunb (%) - All 3 phase voltage unbalance

x. Grid Frequency

xi. Active Power (kW) - All 3 phases + Total

xii. Reactive Power (kVAr) - All 3 phases + Total

xiii. Apparent Power (kVA) - All 3 phases + Total

xiv. Power Factor (PF) - All 3 phases + Total

xv. Displacement Power Factor (dPF) - All 3 phases + Total
xvi. Apk - Peak Current of 3 phases of power stack
xvii. Utilization (%) - Utilization percentage of 3 phases of power stack
xviii. Vdc - DC bus voltage of power stack
xix. Stack Temperature - Temperature of 3 phase IGBTs of power stack
xx. Control Card Temperature
xxi. System Running hours
xxii. Fan Running hours

g. Advanced logging capabilities
   i. The HMI must save a minimum of 50,000 time stamped event logs
   ii. The logs view must be password protected
   iii. The logs should capture system events like System On/Off
   iv. System trip event should be logged with associated trip code and time stamp
   v. User entry into settings should get logged
   vi. Any failed user login attempt (wrong password) should be logged
   vii. Changes in user settings must be logged
   viii. Logs must be accessible day-wise for ease of navigation
   ix. Logs must be arranged in First In - Last Out fashion to display the latest events on top
   x. User must be able to export the logs to an external USB storage device
   xi. HMI must have provision for Ethernet communication
h. The HMI must provide graphical information for the following (minimum) data
   i. Individual harmonic bar chart of 3 phase currents - upto 51st order
   ii. Individual harmonic bar chart of 3 phase voltages - upto 51st order
   iii. Simultaneous graphical display of 3 phase currents and 3 phase voltages on single window with user select-able options

7. The HPFC Panel shall have the following features, in addition to those already mentioned above:
   a. Panel shall be suitable for operation within an ambient temperature between 0ºC and 50ºC
   b. Panel shall have an audible noise level lesser than 70db as per NEMA standard.
   c. Panel shall have a filtering efficiency of at least 98%
   d. Panel shall have a reaction time of less than 200 micro-seconds
   e. Priority selection between the three features - PF compensation, harmonics compensation and load balancing - of the filter shall be programmable using the HMI

f. In the default mode, harmonics compensation is set at 1st priority, PF compensation is set at 2nd priority and load balancing is set at 3rd priority
g. Panel shall also have provision for selection of individual harmonic orders for compensation in the harmonic compensation mode through the HMI
h. Panel shall only compensate the load balancing requirements arising from distributed loading in the three phases or due to two phase loads
i. Any compensation requirements arising due to the unbalanced current in the neutral shall not be compensated (a 4P/4W HPFC Panel will be required for such cases)
j. Auto fold-back of the HPFC Panel if total current requirement exceeds the rated capacity of the filter
k. Bus-bars or cables shall be suitably colour coded and mounted using appropriate insulator supports
l. Suitable clearances shall be provided for the bus-bars and other live parts of the system as per international standards
m. All live parts of the system shall be properly shrouded
n. Inspection terminal strip, number ferruling, and other labelling shall be suitably provided
o. Stickers marked with “DANGER” shall be provided wherever required
p. Detailed drawings and manuals shall be provided wherever required
q. Following protections shall be provided:
    i. Over voltage (AC) protection
    ii. Over voltage (DC) protection
    iii. Phase sequence protection
    iv. Over current protection
    v. One phase disconnection (double phasing) detection/protection
    vi. Over temperature protection
    vii. Temperature sensor abnormality detection
    viii. Protection circuits for the IGBT stack and its components
r. Temperature based de-rating to protect the system and longer operational life
    i. The system will de rate its capacity by sensing the control card temperature
    ii. System will sense abnormally high stack temperature and trip itself to protect the converter with suitable error indication
    iii. The system will sense abnormality with stack temperature sensing circuit and generate a suitable error indication
s. All components and wiring used in the system shall adhere to the relevant ISI and IEC standard

8. The HPFC Panel shall have the following settings options for the user

a. Define priority between Harmonic, Reactive and Unbalance compensation e.g: User can easily choose to do only one of the three or a combination of the three. Filter will utilize its full capacity as per defined priority.

b. Individual harmonic selection

9. INSPECTION & TESTS

The complete assembly shall be subject to routine tests including functional test of the control, protection and interlocking schemes. The routine tests shall be carried out at its place of manufacture.

Routine test results should be a part of the O&M Manual and shall be produced at the time of delivery of the equipment.

The manufacturer shall prepare a programme for routine tests and submit these to the client / consultant at least on month before commencement of the programme.

ROUTINE TESTS:

All tests shall be carried out in the presence of and to the satisfaction of the Employer or his representative and at such times as he may reasonably require.

All samples used for testing shall be to the contractor's expense and shall not affect the quantities to be supplied under this contract.

All instrument used for testing purposes, shall if required by the engineer be calibrated by an approved authority.

The cost of all tests shall be included in the contract price and shall not be quoted for separately.

Routine Tests on Capacitor Bank

All routine tests shall be carried out in accordance with IEC 61921 as per the relevant clauses mentioned against each test. Routine tests shall be carried out by the manufacturer on every Low voltage power factor correction banks before delivery.

- Inspection of the assembly including inspection of wiring and, if necessary, an electrical operation test
- Dielectric test
- Checking of protective measures and of the electrical continuity of the protective circuit
- Verification of insulation resistance

Routine Tests on Capacitor Units

All routine tests shall be carried out in accordance with IEC 60831 as per the relevant clauses mentioned against each test. Routine tests shall be carried out by the manufacturer on every capacitor unit before delivery.

- Capacitance measurement and output calculation
- Measurement of the tangent of the loss angle (tan *δ)* of the capacitor
- Voltage test between terminals
- Voltage test between terminals and container
- Test of the internal discharge device

- Sealing test

TYPE TESTS:

Type tests may be omitted if acceptable test records can be submitted, unless specified otherwise. The design of the low voltage power factor correction banks tests shall conform to IEC 61921 / IEC 61439-1/2 and must include the following:

Type Tests on Capacitor Bank

All type tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 61921 as per the relevant clauses mentioned against each test.

- Temperature Rise Test
- Di-electric Test
- Short-circuit withstand strength
- Effectiveness of the protective circuit
- Clearances and creepage distances
- Mechanical operation
- Verification of Degree of Protection

Type Test on Capacitor Unit :

All type tests shall be carried out in accordance with the International Electro-technical Commission (IEC) Publication No. IEC 60831 as per the relevant clauses mentioned against each test. Every capacitor sample to which it is intended to apply the type test shall first have withstood satisfactorily the application of all the routine tests.

- Thermal stability test
- Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature
- Voltage test between terminals
- Voltage test between terminals and container
- Lightning impulse voltage test between terminals and container
- Discharge test
- Ageing test
- Self-healing test
- Destruction test

11. AUTOMATIC POWER FACTOR CORRECTION

The equipment shall be complete with all necessary accessories and components as required as per IS standard.

Supply, installation, Testing and Commissioning of automatic power factor improvement (indoor) with Capacitor Banks (APP Type), type test according to IEC 61439-1&2,IEC 61921 including interconnection with LT panel with appropriate size of electric cable. The panel shall be indoor, factory fabricated, dust and vermin proof (IP 42) type, suitable for 1100 V grade 3 phase 50 HZ AC supply, floor mounted in 12 stage with micro processor along with fully ventilated both side opening.

For panel constructional detail specification refer respective section of LV Switchgear.

a) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.

b) The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an overvoltage on the units in parallel with it, which will result in the failure of the parallel units.

c) The complete capacitor banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and free standing type.

d) All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate and then painted with two coats of zinc rich primer paint. After application of primer, two coats of finishing synthetic enamel paint oven baked/stove shall be applied.

e) The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary louvers may be provided in the cubicle to ensure proper ventilation.

f) Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of the latest edition of IS : 2834.

g) All panels of capacitor banks with MCCBs, Contactor, minimum 8 stage automatic power factor correction relay enclosed in IP 42 compliant CRCA Sheet Steel enclosure.

h) Capacitors shall be double layer All poly Polypropylene (APP) type having following specifications and conform to IS 13925:

i) The capacitors shall have Low Dielectric Loss of 0.5 W/ kVAR.

j) All capacitors shall be provided with 7% de-tuned filter along with all accessories and protections.

k) Any change in rated voltage level of the capacitor bank due to the filter or otherwise shall be considered by the Contractor. The indicated rating of capacitor banks are at rated voltage of 415V.

l) The banks shall be switched ON and OFF in both Auto as well as Manual mode. An “Auto/Manual” Switch at the incomer feeder shall be provided.

m) All necessary auxiliary contactors of suitable duty along with feeder accessories are included in scope. All power Contactors for capacitor switching shall be of required duty.

n) Manual operation shall be done with recess type panel mounted ON/OFF pushbutton with delay timer.

o) Minimum current rating under site conditions, of circuit breakers, Contactors, and cables shall be at least 150% of rated capacitor current.

p) Capacitors shall be mounted in such a way that heat dissipation is proper and the capacitors are accessible for maintenance and inspections.

q) Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.95 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.

r) The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/ removal of capacitor or other components and maintenance considerations.

s) Each unit shall satisfactorily operate at 130% of rated KVAR including factors of overvoltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10% above the rated voltage, excluding transients.

UNIT PROTECTION

Each capacitor unit shall be individually protected by a MCCB Breaker suitably rated for load current and short circuit capacity, so that a faulty capacitor unit shall be disconnected by the breaker without causing the bank to be disconnected. Thus, the breaker shall disconnect only the faulty unit and shall leave the rest of the units undisturbed.
The Inputs to the APFC system is Voltage input from two phases and current input from the third phase. Out of two phases of voltage one phase voltage is taken as Reference 0 and other phase voltage as 440 V. APFC need to be installed CT (Current Transformer) on the third phase at main incomer ACB after transformer, which will give signal to the APFC Relay. Based on this inputs the ASIC (Application Specific Integrated Circuit) OR Call it as Microprocessor internal to the APFC Relay will give output signal to relay outputs which will energize coil of the contactor so that the contactor come in line connecting the capacitor bank in circuit. However this is step correction means PF is corrected in steps. The Voltage rise due to connection of capacitor banks is marginal. There will be no frequency correction with APFC System.

APFC PANEL ACCESSORIES

a) Power capacitor and control panel shall be housed in metal enclosed cubicle. Power capacitor shall be housed in the lower compartment and capacitor control panel at top compartment.

b) The control equipment including capacitors shall be mounted in a panel of cold rolled sheet steel. The panel shall be of indoor type.

c) Bus bars shall be of aluminium conductor and high conductivity.

d) Isolating switch

e) Contactor with overload element

f) APFC Relays responsive to current/voltage/KVAR/PF as specified for automatic switching shall be of microprocessor based suitable for state board Electricity with reduced power factor.

g) Sequencing devices, timers and auxiliary relays for automatic sequential switching of the capacitors in and out of the circuit.

h) Auto-manual selector switches

i) Push button for opening and closing the power circuit.

j) Red and green cluster LED lights for capacitors ON/OFF indication

k) Protective numerical relays to protect the healthy capacitor units when one unit fails in a series connection

Space heater and cubicle lighting as per the requirements.

All routine and type test shall be carried out in the presence of Employer / Employer's Reresentative as per relevant standards.

12. CABLES AND CABLE CARRIER SYSTEM

SCOPE

This specification also covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's works and delivery to site of HT Cables 11 kV and LT Cables, Cabling Accessories, conduits and pipes etc.

APPLICABLE CODES & STANDARDS

The design, construction, manufacture and performance of the equipment/components shall conform to latest applicable standards as on date of submission of the bid and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment/components will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable standards for cables IS 1554, 7098, 8130, 5831, 3975, IEC 60183, 60227, 60502, 60885, 10418.

TECHNICAL SPECIFICATION FOR CABLES & CABLE TERMINATION

The various types of cables covered in this specification shall meet the following requirements:

XLPE Insulated HV Power Cables

The conductors shall be screened by extruded semi-conducting compound and XLPE insulated. The cores shall be screened by extruded semi-conducting compound in combination with non-magnetic metallic tape (copper tape preferred).The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST-2. Core identification shall be by printed numerals. The construction, performance and testing of the cable shall comply with IS 7098-Part 2 (Cross Linked Polyethylene Insulated PVC Sheathed Cables for working voltages from 3.3kV upto and including 11kV).

1100 V Grade XLPE Insulated Power Cables

The cable shall be extruded XLPE insulated. The inner sheath over laid up cores and outer sheath over the armour shall be extruded PVC compound type ST-2. Core identification shall be by printed numerals. The construction, performance and testing of the cable shall comply with IS 7098-Part1 (Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 V).

1100 V grade PVC insulated Power / control cables

The cables shall be insulated with extruded PVC compound type C, provided with inner sheath and outer sheath of extruded black PVC compound type ST-2.

The construction, performance and testing of the cable shall comply with IS 1554 - Part 1 (PVC insulated heavy duty electric cables for working voltages upto and including 1100 V).

1100 V Grade Lighting/Misc./Light duty unarmoured cables

Cables shall be insulated with extruded PVC type-C. Outer sheath shall be extruded black PVC type ST-2. The sheathed cables shall be weather proof suitable for indoor/outdoor use. Twin and multicore cables shall be laid up and filled with thermoplastic material, bound by plastic tape and provided with outer sheath.

The construction, performance and testing of the cable shall comply with IS 694 (PVC insulated cables for working voltages upto and including 1100 V).

For all LT power and control cables, double compression glands with aluminium lugs for Aluminium cables and tinned Copper lugs for Copper cables shall be used in indoor and outdoor application.

The termination shall be inclusive of miscellaneous items such as clamps, cleats, cable tags, cable markers etc.

In general cable installation works shall be carried out in accordance with IS 1255 – 1983, latest version. At road crossings, the depth of the Pipe shall be minimum 1m else proper concrete encasing shall be provided.

For Underground cables, cable marker shall project 150mm above ground and shall be spaced at an interval of 30 metres, and at every change in direction. They shall be located on both side of road and drain crossings on finished surface like foot path etc. Top of cable marker/joint marker shall be sloped, to avoid accumulation of water/dust on marker. The marking shall be accomplished with a separate colour tiles/ paver block for highlighting the route of the cable.

Cable tags shall be provided on all cables both at feeder pillar end as well as on each pole (just before entering the equipment enclosure).

Cable Glands

a) Double compression type cable glands shall be used for the termination of all the power and control cables. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.
b) For single core cables, gland shall be with brass ring.
c) Cable glands shall be with metric threads.
d) Cable glands shall be conical (& not flange type).

Cable Lugs

a) Cable lugs shall be of tinned Copper, solder less crimping type for Cu cables & Al lugs for the Al cables.
b) The current rating of the lugs shall be same as that of the respective cable conductors.
c) Ring type cable terminations shall be used.
d) Insulated lugs are not acceptable for any cable terminations.
e) Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.
f) Double hole extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.
g) Fork terminals shall be used for luminaires & decorative switch/ socket. Pin terminals may be acceptable during execution only in case other terminals/ lugs cannot be accommodated.
h) Reducer / wire pin terminals shall be avoided for MCB terminations. MCB terminations shall be with ‘long palm terminals.
i) All terminations in Feeder Pillars / enclosure for earthing & neutral busbars / terminals shall be with ring type terminals.
j) All earthing terminations shall be with ring type lugs only.

k) All control & interlock cable terminations shall be with ring type lugs.

l) Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs [This shall especially be ensured for Al cable terminations & any bimetallic terminations (Cu cable termination using tinned Copper lugs)].

m) If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

The cable carrier system covers the supply of cable racks, cable trays and its supporting accessories hardware and their installation. It shall be the responsibility of the Contractor to complete the cabling system in all respects.

Cable trays shall be of Galvanised Steel and of perforated type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as required. All hardware (i.e. bolts, nuts, screws, washers, etc.) shall be hot dip galvanised. (galvanisation thickness not less than 70 microns).

Each 2.5 metre section of all types of cable trays and all elbows, tees, crosses, etc. shall be provided with two side coupler plates and associated bolts, nuts and washers.

REQUIREMENT OF SPECIAL SHEATH FOR FRLS CABLE

Tests and Test Equipment

Cables shall be subjected to routine and acceptance tests in accordance with standards specified Test methods shall conform to IS 10810 (Methods of Test for Cables). Type tests and optional tests according to applicable standards shall be conducted on cables as specified. Contractor shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratory traceable to National Standards. Outer sheath for FRLS/FS cables shall meet the following test requirements related to flame retardance, low smoke emission, low acid and toxic gas emission. The Contractors shall have proper test apparatus to conduct all the relevant tests as per the applicable Standards mentioned herein.

Test for flame Retardance

a) Oxygen Index

The critical oxygen index value shall be minimum 29 when tested at 27 +/-2 deg.C as per ASTM-D-2863 and the temperature index value shall be minimum 250oC at oxygen index of 21 when tested as per NES 715.

b) Flammability

- Cables shall pass test under fire conditions as per IS-10810- Part-53.
- Cables shall also pass tests as per IS-10810 Part- 61 & Part-62.
- Fire survival cables in addition to tests (i) and (ii) above shall pass tests as per IEC-331.

Test for smoke generation

The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.

Tests for acid gas generation

The hydrochloric acid generation when tested as per IEC 754-1 shall be less than 20% by weight.

Tests for Resistance To Ultra Violet Radiation

This test shall be carried out as per DIN 53387. The retention values of tensile strength and ultimate elongation after the tests shall be minimum 60% of tensile strength and ultimate elongation before test.

Tests for water absorption

Outer sheathes shall be subjected to tests for water absorption as per IS 10810. When additional characteristics are required, the tests shall be as agreed to between Employer and VENDOR before the placement of order.

All Routine test as per the IS standards shall be carried out in the presence of Employer / Employer's Representative at the Manufacturing plant.

13. INDOOR AND OUTDOOR LIGHTING & SMALL POWER SYSTEM

GENERAL REQUIREMENTS

The Lighting system includes the following items.

- Lighting fixtures complete with Lamps and accessories (lumen per watt shall be indicated)
- Lighting system equipment (ISI make)
- Light control switches, receptacle units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system.
- Lighting fixture supports, street lighting poles
- Main Lighting distribution board, lighting panels
- Multi core cables for street, boundary lighting
- PVC Conduits

Load balancing of lighting system shall be made.

DESIGN

The lighting system design shall comply with the acceptable norms and the best engineering practices. The lighting layout shall be designed to provide uniform illumination with minimum glare. The layout design shall meet all the statutory requirement, local rules etc.

The value of the ratio of spacing (S) to mounting height (H) shall be commensurate with the type of fittings selected and uniformity of illumination.

APPLICABLE CODES & STANDARDS

All standards and codes of practice referred to below shall be the latest edition including all official amendments and revisions.

- 3 pin plugs & sockets : IS 1293
- General safety requirements for luminaires : IS 1913
- Luminaires for street lighting : IS 10322(Part-5, S 3)
- Fitting for rigid steel conduits for electrical wiring : IS 2667
- Code of practice for interior illumination : IS 3646 & IS 6665
- Switches for domestic & similar purpose : IS 3854
- Electric ceiling type fans & regulator : IS 374

- Code of practice for electrical wiring installation

1.11.1.1 (system voltage not exceeding 650Volts) : IS 732

- General lighting LED and LED Modules : IS 16101
- Self-ballast LED lamps for general lighting services: IS 16102 (Part-1 & 2)
- LED modules for general lighting : IS 16103(Part-1 & 2)
- Safety of lamp control gear : IS 15885 (Part-2/sec-13)
- DC or AC supplied electronic control gear for

1.11.1.2 LED modules : IS 16104

- Method of measurement of lumen maintenance

1.11.1.3 of solid state light (LED) sources : IS 16105

- Method of electrical and photometric

1.11.1.4 measurements of solid state light (LED) products : IS 16106

- Luminaries performance : IS 16107 (Part 1 &2)
- Photo biological safety of lamps and lamp system: IS 16108

LED LUMINAIRES

LED luminaires shall be used for internal & outdoor lighting. Luminaires shall be installed to permit ease of maintenance. The Contractor shall provide all equipment necessary to carry out maintenance on the lighting installation and demonstrate its operation to the satisfaction of the Engineer.

MCB (DP For single phase MCB and 4P for three phases MCB DB) and DP RCCBs for each phase shall be provided at the incomer of Lighting panels and SP MCB for outgoing feeders.

Comprehensive on-site warranty of 05 years from the date of Go Live shall be provided for all the components including LED Street light fixtures.

LANDSCAPE LIGTHING SYSTEM

The illuminance level for road lighting in India is governed by IS 1944 (Part 1& 2): 1970/ Code of practice for lighting of public thoroughfare.

The layout for street lighting system will be planned in such a way that uniformity ratio as required by IS: 1944 is maintained.

The post top decorative light fixture shall be mounted on MS pole with PU paint. The thickness of the paint shall be 80-90 micron. The colour for the paint shall be as per direction of Engineer-in-charge.

All the Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading .i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3:2000, pr EN-40-3-3.

All pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations .i.e. from inside and outside.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Aesthetic appearance - All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

The poles and bracket shall be hot dip galvanized as per is 2629/ IS 2633/ IS 4759 standard with average coating thickness of 75 micron. The galvanizing shall be done in single dipping.

Top Mountings -The galvanized mounting bracket shall be supplied along with the Poles for Installation of the luminaries.

The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Electrical connections - Four way connectors shall be provided along with Slide lock suitable for connecting 1.1 kV grade, 4 core Al cable. It shall also in house 1 no. 6A DP MCB, 2.5 mm² connectors for looping with 2.5 mm² Copper wires for connecting to the luminaries through 1.1 kV grade, 3Cx2.5 mm² PVC insulated copper conductor flexible un-armoured Cable from the terminal block to the fixture within the pole. All the cables laid through the pipe shall be without any joint.

Two nos. earth terminals shall be provided at the bottom of the pole (diagonally opposite) suitable for connecting 25x6 mm GI earth strip or 6SWG GI wire for earthing of the poles.

Two nos. 50 mm NB HDPE Sleeves of suitable length shall be provided through the foundation upto the Junction Box for entry of power cable.

The BIDDER shall carry out all the relevant tests and inspection in the presence of the EMPLOYER or Third Party Agency, as may be selected by the EMPLOYER, before the dispatch of the poles at no extra cost to the EMPLOYER.

The BIDDER shall inform the EMPLOYER at least FIFTEEN (15) days in advance, about the manufacturing programme so that arrangement can be made for inspection. EMPLOYER reserves the right to waive the inspection at any stage.

All the material/equipment/accessories shall be supplied with manufacturer's test certificates.

BIDDER shall submit the Proposed Product Catalogue, Detail Data sheet, spare parts list and drawing of Pole & Bracket along with the BID for each product quoted.

BIDDER shall arrange for all the tools and equipments.

The pole shall be M20 concrete foundations shall be provided for all the poles. Approx dimension of the foundation for evaluation purpose is 600X600X200 mm. However, BIDDERs shall design as per the stability requirement and Soil bearing Capacity of each location. The Poles shall be bolted on a pre-cast foundation with minimum four foundation bolts for greater rigidity

APPLICABLE STANDARDS

Sr.No.	**Brief Title**	**IS/IEC Code**
1.1	Testing procedure of photometric testing for LED luminaires	LM 79
1.2	Testing procedure on the lifespan of LEDs	LM 80
1.3	National Lighting Code	SP72

Sr.No.	Brief Title	IS/IEC Code
1.4	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources	IS:16105
1.5	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products	IS:16106
1.6	Limits of Harmonic Current Emissions	IS 14700-3-2
1.7	DC or AC supplied electronic control gear for LED modules performance requirements	IEC 62384
1.8	Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules	IEC 61347-2-13
1.9	Environmental Testing: Test Z- AD: composite temperature/ humidity cyclic test	IEC 60068-2-38
1.10	Electro Magnetic compatibility (EMC)- Limits for Harmonic current emission— (equipment input current ≤ 16 A per phase)	IEC 61000-3-2
1.11	EMC Immunity requirement	IEC 61547
1.12	LED modules for general Lighting-Safety requirements	IEC 62031
1.13	Classification of degree of protections provided by enclosures (IP Codes)	IEC 60529
1.14	Fixed general purpose luminaries	IEC 60598-2-1
1.15	General Lighting - LEDs and LED modules – Terms and Definitions	IS:16101 / IEC TS 62504
1.16	LED Modules for General Lighting Part 1 Safety Requirements	IS:16103(Part1)
1.17	LED Modules for General Lighting Part 2 Performance Requirements	IS:16103(Part2)
1.18	Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 D.C. or A.C. Supplied Electronic Control gear for Led Modules	IS:15885(Part2/Sec13)

ENVIRONMENTAL CONDITION

The average atmospheric condition during the year is mentioned below. The equipment shall be designed to work in such environmental conditions:

Maximum ambient air temperature: 50° C

Max. Relative humidity: 90%

Average Rainfall: 55 inches

Atmosphere: Dusty and Heavy chemical smoke at times in certain areas.

The equipment shall be suitable to sustain and work in the humid and corrosive atmosphere of the city.

LUMINAIRE DESCRIPTION - Outdoor

The Luminaires shall have a sturdy and corrosion resistant high pressure Die cast Aluminium housing with weatherproof gasket for lamp and control gear accessories. The Housing shall be Epoxy coated, without any cracks or thorough holes, made in a single piece of die-cast LM6 aluminium alloy. The luminaries shall be totally enclosed, dust tight and water proof.

Heat sink used should be aluminium extrusion having high conductivity. The dimensions of luminaries shall be optimum and adequate to permit sufficient heat dissipation, through the body itself, so as to prevent abnormal temperature rise inside the lantern and consequential damage to the cover and gasket materials, LEDs, lenses and electronic drivers. Heat sink must be thermally connected to MCPCB/ LED light source.

The Luminaries Housing shall be suitable for termination of Cable with Double Compression Cable Glands.

Housing protection: IP-66. If the LEDs and LED Driver are in different compartments, then the two compartments must be individually IP-66. For achieving IP-66, proper gaskets should be provided. Test certificate of NABL accredited laboratory is to be submitted for the luminaire model/rating offered.

Luminaires should conform to the photometric Distribution / requirements of Cut-Off / Semi Cut – off light distribution and optics as classified in IS 1944.

Suitable number of LED lamps shall be used in the luminaries. The manufacturer shall submit the proof of procurement of LEDs from OEMs at the time of testing.

The Luminaries shall be provided with high tensile heat resistant toughened glass or UV resistant polycarbonate cover fixed with stainless Steel screws.

An extruded silicon loop gasket shall be provided in the lantern body to ensure a weather proof seal between the cover and the metal housing to exclude the entry of dust, water, insects, etc. Luminaries should conform to degree of protection of IP 66 or above. Felt gasket will not be accepted.

Year of Manufacture, Batch No., Serial Number or Identification No. Luminaries Manufacturer's Name / Logo, Wattage and Frequency should be embossed on the housing.

LED luminaries, should conform to the various National / International standards for safety & performance. Manufacturer should provide test reports as per LM 79 & LM80. Lumen maintenance report as per LM 80 guidelines shall be submitted for the LEDs used along with the BID.

Luminaries should conform to the IS standards for Safety & Performance and test certificates as per IS 16107 should be provided by the manufacturer. In case of luminaries are imported, the BIDDER shall conform to test parameters as per UL or equivalent standards.

The electrical component of the LED and LED driver must be suitably enclosed in sealed unit to function in environment conditions mentioned earlier.

All the connecting wires inside the Luminaries shall be low smoke halogen free, fire retardant cable.

Adequate protection against Overloading, Short Circuit, Over Voltage, over temperature, Under Voltage, String Open shall be provided within the Luminaries.

Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

The equipment should be compliant to IEC 60598-1, IEC 62031 and IEC/ PAS 62612 depending on the type of luminary.

All the material used in the luminaries shall not contain any toxic material/ metal like mercury; shall be halogen free and fire retardant confirming to relevant standards.

The Manufacturer shall have all the relevant testing facilities certified by an accredited laboratory and shall be offered for inspection to the EMPLOYER for verification of the required parameters and tests. BIDDER shall confirm the same in the BID.

The control gear shall comply to the provisions of IEC 61347-2-13, IEC 62031 and IEC 62384 as appropriate.

The lighting fixtures offered shall comply with the following requirements:

LUMINAIRE DATASHEET - Outdoor

Sr. No.	Parameters	Requirements / Value
1.	Type	LED Luminaries complete with all accessories including driver, internal wiring with flameproof wires, etc., for Outdoor Lighting
2.	LED chip make	Nichia, Philip Lumiled, Osram, CREE
3.	Rated Voltage	230V
4.	Operating Voltage Range	Single phase 140-280 volts AC. But luminaries shall be tested for 100V to 300 V AC
5.	Frequency	50 Hz +/- 3%
6.	Power Factor	> 0.95
7.	LED wattage	1-3 Watt
8.	LED chip Efficacy	>135 Lm/Watt system lumen output at 25 degree C, supported by LM80 report, to be submitted.

9.	LED Drive current	>=350 mA<750 mA
10.	LED Beam Angle	CONTRACTOR to decide
11.	Colour Temperature	≥5500K.
12.	Rated Minimum LED Life (L85)	50000 Burning Hours (same should be supported by LM80 report)
13.	System efficacy	≥ 110 Lm/Watt
14.	Total Lumen Output	CONTRACTOR to offer
15.	Colour Rendering Index of Luminaires	>70
16.	System Power Efficiency	≥ 90%
17.	Driver Type	Constant Current based Electronic Driver
18.	Driver Efficiency	> 90%
19.	Maximum temperature rise for Driver	<30 Deg C at 45 Deg C ambient
20.	Operating Temperature Range	-20 Deg C to + 50 Deg C
21.	Luminaries body temperature after 12 hours of continuous operation	≤ 30 Deg C from ambient
22.	Junction temperature	< 85 Deg C - self certified by Manufacturer
23.	Heat Sink Temperature	≤ 15 C from ambient
24.	Solder point temperature	< 70 Deg C

25.	Operating Humidity	10% to 95% RH
26.	Control Gear	Prewired with low smoke halogen free, fire retardant e beam cable up to terminal block. Fuse protection shall be provided inside.
27.	Operating Hours	Dusk to Dawn (max 12 Hrs.)
28.	Total Harmonics Distortion (THD)	<10%
29.	Construction	High power SMD and LED must be mounted on Copper MCPCB for high thermal conductivity and fastest heat transfer from the LED junction
30.	IP Protection	IP66 or more; no water stagnation anywhere
31.	Luminary Housing	Pressure Die Cast Aluminum (grade 5000 or similar) housing with corrosion resistant polyster powder coating & safety as per IEC 60598 / IS 10322. Mounting bracket with aiming & locking facilities. Large surface area with fins to dissipate the heat to ambient air
32.	Heat Sink	Well-designed thermal management system with defined heat sink - Aluminium extrusion
33.	Clip / Fastners	Corrosion free/ Stainless steel.
34.	Wire	The connecting wires used inside the luminaries, shall be Low Smoke Halogen Free, fire retardant e-beam cable and fuse protection shall be provided in input side.
35.	Materials	Halogen free and fire retardant confirming to UL94.
36.	Optics	Secondary lens array should be provided for optimized roadway photometric distribution. Lens

		material should be optical high grade PMMA with more than 90% light transmittance.
37.	IK protection for Optic Cover	>IK07
38.	Photometric measurements	LM-79/IS16105.
39.	Minimum Surge Protection	>10 kV
40.	Protection Required in Driver Module	
a.	Short Circuit	Yes; Constant current limit mode.
b.	Open Circuit	Yes
c.	Over Voltage	Yes; Auto Isolation
d.	Over Temperature	Yes; Auto Shut Off.
e.	Under Voltage	Yes;
f.	String Open Protection	Yes;

GENERAL REQUIREMENT FOR LED LIGHT FIXTURES (INDOOR)

- All LED luminaires shall be provided with toughened glass and shall have thickness of sufficient strength and high efficiency prismatic diffuser under the LED chamber to protect the LED and luminaries.

- Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution for LED

- The fixture shall be designed so as to have lumen maintenance of at least 70% at the end of 50,000 hours (L70) at design temperature of 35-degree C & CRI=>90
- Lighting Colour temperature shall be 3200K ideal for performance with RGBW Colour mixed LED Lights
- Adequate heat sink with proper thermal management shall be provided.

- Minimum view angle of the LED shall not be less than 120 degree.

- Power factor of complete fitting shall be more than 0.95 at full load 240V and THD<8%.

- The LED luminaire shall be free of glare.
- The luminaire should be an inbuilt surge protection of not less than 4 KV to prevent in damage to the driver in case of sudden voltage surge.
- All light fixtures shall have fuse & internal safety protections.
- All surfaces of the luminaire / control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.
- The housing shall be extruded aluminium natural anodized finish with high efficiency diffuser and LED mounted on PCB with integral electronic driver.
- The finish of the luminaire shall be such that no bright spots are produced either by direct light source or by reflection.
- Each luminaire shall have a terminal block suitable for loop-in, loop-out and T-off connection by 1100 V, 1 core, PVC insulated copper conductor wires up to4 sq.mm in size.
- All metal or metal enclosed parts of the luminaire / control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.
- All light fixtures shall be sleek & unique designed light weight body.

Indoor Luminaire Datasheet

Sr. No.	Parameter	Requirement / Value
1.	Type	LED Luminaries complete with all accessories as per design basis
2.	Rated Voltage	230 V
3.	Expected Frequency	50 Hz +/- 3%
4.	Operating Voltage Range	140 V to 270 V but luminaires shall be tested for 100V to 300 V AC
5.	Power Factor	> 0.92
6.	Operating Temperature Range	0 Deg C to 50 Deg C
7.	Working Humidity	10% - 90% RH
8.	Driver Type	Constant Current based Electronic Driver
9.	Driver Efficiency	> 85%
10.	Driver Life	>50000 hrs.
11.	Protection required in Driver module	
a.	Short Circuit	Yes
b.	Over Voltage	Yes
c.	Over Temperature	Yes
d.	Under Voltage	Yes
e.	String Open Protection	Yes

Sr. No.	Parameter	Requirement / Value
12.	Luminaire IP Protection	IP 20
13.	Minimum Surge Protection	>10 KV
14.	THD	<10%
15.	Rated Minimum LED Life (L70)	>50000 Burning Hours
16.	Rated Minimum Driver Life	50000 Burning Hours
17.	CRI	As per Standard mentioned in Design Criteria
18.	Make of LED	Cree / Nichia/ Philips Lumiled/ Osram
19.	Make of Driver	Cree / Nichia/ Philips Lumiled/ Osram
20.	Operating Hours	Dusk to Dawn (max 12 Hrs.)
21.	System Efficacy	>110lm/W
22.	Colour Temperature	5000K – 6000K
23.	CRI	>70
24.	Illumination Regulation	<5%
25.	Material used for following	
26.	Housing	Metallic CRCA Powder Coated Body/Extruded aluminum frame
27.	Heat Sink	Aluminium extrusion
28.	Clip / Fasteners	Stainless steel.
29.	Diffuser	PC Glossy/Opal PMMA
a.	Maximum temperature of Heat sink	<80 Deg C
b.	IK protection of Optic Cover	>IK05
c.	Wires used Inside Luminaries	Cu conductor, low smoke halogen free, fire retardant e-beam cable

The Contractor shall submit catalogue of the light fixtures for selection by the Employer or Employer's Representative.

TESTING OF LUMINAIRE

The Routine test on each of the offered Luminaire shall be carried out by the BIDDER before dispatch. Following tests shall be carried out as routine tests by the BIDDER for the offered Luminaries:

(a) Visual and Dimensional check
(b) Checking of documents of purchase of LED
(c) Insulation resistance test
(d) HV test
(e) Reverse polarity

The Acceptance test shall be carried out by EMPLOYER or EMPLOYER's Representative on a sample of the lot offered for Acceptance. The Lot shall be different from the lot from which the Type test samples have been drawn. The cost of the testing shall be borne by the BIDDER. Following tests shall be carried out as Acceptance tests by the BIDDER for the offered Luminaries:

(a) Visual and Dimensional check
(b) Checking of documents of purchase of LED
(c) Insulation resistance test
(d) HV test
(e) Over voltage protection
(f) Surge protection
(g) Reverse polarity
(h) Lux measurement

Following Type tests reports shall be provided by the BIDDER for the offered Luminaires along with the BID;

(a) Resistance to humidity
(b) Insulation resistance test
(c) HV test
(d) Over voltage protection
(e) Surge protection
(f) Reverse polarity
(g) Temperature rise Test
(h) Ra (Colour Rendering Index) measurement test
(i) Lux measurement
(j) Fire retardant Test
(k) Test for IP 66 protection
(l) Endurance Test,
(m) Life Test
(n) Photometric Measurements Test Report (IES LM 79)
(o) LED Lumen Maintenance Test Report (IES LM 80)
(p) Vibration test as per ANSI
(q) Drop Test

DRAWINGS AND DATA

All Drawings, data, technical particulars, calculations, detailed literature, catalogues, test certificates etc shall be submitted along with the bid/ after award of contract as specified in Bid Document.

14. AUDITORIUM STAGE LIGHTING

SCOPE

The detailed design, preparation of all necessary GFC, As built, shop drawings, supply for all necessary materials, testing, inspection and delivery to site, installation, commissioning of the stage lighting systems, general lighting and their associated accessories along with power & control wiring, conduiting, earthing, lighting panel, Integration of the complete system etc, complete in all respects for Auditorium.

The system shall be designed in accordance with the latest applicable electrical rules, all currently applicable standards codes of practice, IS, BS, DIN or IEC. The auditorium lighting shall be as per relevant illumination standards. The contractor shall submit the auditorium lighting standard for reference and give presence of auditoriums designed in line with the same standard.

All special fixtures, control devices etc. not specifically mentioned but that are required for the safety and efficiency of the lighting equipment shall be included in the supply without any extra cost to the contract. Nothing in this specification shall be construed to relieve the CONTRACTOR of his responsibility. Where no standards are available, the supply items shall be backed by test results, shall be of good quality and workmanship and any supply items which are bought out by the VENDOR shall be procured from approved manufacturers acceptable to the PURCHASER.

Stage lighting Systems:
Stage will have Lux levels adjustable from 0 to 2000 Lux based on requirement of Stage lighting. Auditorium Lighting to be designed for events like:

- Lighting for the Live Performance.
- Lighting for Drama / Dance / Singing & Multipurpose use.
- Presentation and Speech.
- Live Control through DMX for Lighting Fixture with Multiple universes.
- RGB Illumination and High CRI Based Profile spots.

Specific Requirement;

1. Stage Lighting Truss Bar: Over Head Light Bar 50NB dia pipe of full-length trussing with adequate clamps, End Caps on the Pipe end, this lighting bar painted inside, outside with zinc chromate primer finally coated with black quick drying enamel paint to mounting for stage lighting, which is suspended from bars above the stage to focus/Wash the stage.
2. Truss FOH "FRONT OF HOUSE" LIGHT BAR: 50NB dia pipe of full-length trussing with adequate clamps, End Caps on the Pipe end, this lighting bar painted inside, outside with zinc chromate primer finally coated with black quick drying enamel paint required which is suspended from ceiling in front of stage to focus stage.
3. Side light Bar: Stage will have side illumination through the Side Light Bar which are planned on each side. 50NB dia pipe of full-length trussing with adequate clamps, End Caps on the Pipe end, this lighting bar painted inside, outside with zinc chromate primer finally coated with black quick drying enamel paint
4. Pre-painting treatment of 7 tank chemical process to be made on the metal enclosure to ensure rust free of metal part for years together.
5. Each of the lightbar are to be planned with enough No. of Raw power points, Control DMX points to enable the light fixture control through a single network.
6. Power outlets from fixed light bars, foot-light points, and skirting level sockets are wired individually to positions on the lighting patch panel.
7. Power outlets from side ladders, are individually connected to trailing cables terminated in metal clad plugs. Power outlets are provided on the stage walls wired individually to positions on the patch panel. The trailing cable plugs are plugged into these power outlets on the walls.
8. Additional light points, also terminated in the patch panel, have been provided at skirting level. These will serve any additional portable lighting that may be required.
9. Wiring for Stage lighting: -Using PVC Insulated 2.5 sqmm 3-Core FRLS Cu. Cond. Cable for each socket; starting from the Dimmer Rack / MCB Box Panel to the Lighting bars or stage points terminated at junction box with 2 x 16 Amp. Sockets per box along with cable tray (all boxes to be mounted on Light Bars & all points to be marked & numbered).
10. Any dimmer circuit can be patched to any one light point. Each light point to be protected by a 10A MCB in the patch panel. All patching to be 'soft patch' type, with each light connected to an individual dimmer.
11. Each electronic dimmer circuit to have an analogue control signal input.

12. Additionally, halogen flood lights have been provided for general lighting of the stage. Additional power outlets have been provided on the light bars for this purpose. These power outlets are directly connected to mains supply via switches provided both backstage and in the control room.
13. A lighting controller console has been provided in the control room with a control cable interconnecting the control console with the power equipment.
14. The controller has features of memorizing several 'scenes' and 'pages' and has facilities for 'chase', 'audio input' etc
15. Lighting Fixtures shall be provided with suitable Clamps and required safety chains/ wires to ensure double safety.
16. Entire System of Stage lighting should have a main incomer panel having a distribution of the power system to different applications. For detailed specification, please refer respective section of LT Panel & cables. All cables shall be FRLS type.
17. All lighting fixtures shall be dimmable with DMX.
18. Side Ladder: 50x25mm MS tube pipe ladders of following size 8ft x2 ft to be provided on sides of the stage.
19. Luminaries:

Sr. No.	Type of Light Fixture	Description
1	LED COB Surface Light	Power - 200W COB LED Voltage - 100-240V 50Hz Colour Temperature - minimum 3200K CRI & TLCI >90 DMX 512 Dimming Linear Dimming from 0 – 100% Strobe: High-speed electronically adjusted strobe up to 1-25 times/sec or random strobe Dimming: The total dimming channel can simultaneously control the light and dark changes and close light of 2 main colours IPX4 with protection against water spray Applicable life: 50000 hours
2	RGBW LED Parcans Light	Illuminate the Indoor stage with unlimited colour effects Power – min 60W to Max.100W Voltage - 100-240V 50Hz CRI>90, 3200K CCT Colour temperature LED source: 3W (R14, G14, B14, W12) DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras Mode: DMX /Sound / Auto / Master -salve Strobe: High-speed electronically adjusted strobe up to 1-25 times/sec or random strobe

Sr. No.	Type of Light Fixture	Description
3	LED Profile Spot 19 deg code	Lux@2m above 27,000 suitable to illuminate the key presenter or talent on stage. Power – min 300W Voltage - 100-240V 50Hz CRI>90, 3200K CCT Colour temperature DMX 512 Dimming IP 20 protection. Flicker free 100% for TV & Film cameras Mode: DMX /Sound / Auto / Master -salve
4	Halogen Flood Light with R7s base code	Power - 1000W Aluminium reflector with double ended R7s Base lamp holder On / Off toggle switch Black powder coated and Robust pre-treated fabricated housing with 16amps 3pin CE plug and normal yoke but lamp and accessories.
5	LED Follow Spot Light	Follow Spot Light with daylight 400- 450W COB 6500K White LED source having 5 Colours inbuilt, fader-based intensity control, dimming and irish effects. Manual Control Panel - Faders IP20 Rating of Protection with Aluminium Die casted Body. Mode: DMX /Sound / Auto / Master -salve Strobe: High-speed electronically adjusted strobe up to 1-25 times/sec or random strobe Linear Dimming from 0 – 100%
6	Cyclorama Light	Power AC 100-240V/50Hz, 300-330W with Power on mains connectors DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras IP-20 Protection
7	LED Blinder Light	Strobe option and smooth dimming to illuminate Stage with uniform light intensity levels. Power input: 100-240V 50Hz Power: 4x 100W Light Bead control: single point control Colour temperature: 3200K, CRI>90 DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras IP20 protection

Sr. No.	Type of Light Fixture	Description
8	LED Par Light	Power input: 100-240V 50Hz Power: 3WX 54 pcs Light Bead control: single point control Colour temperature: 3200K, CRI>90 DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras IP20 protection
9	LED Par RGBW Light	Power input: 100-240V 50Hz Power: 3WX 54 pcs Light Bead control: single point control Colour temperature: 3200K, CRI>90 DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras IP20 protection
10	Moving Head Beam Light	Power supply: 200-240V, 50Hz Power consumption: 800W Colour temperature: 3200K, CRI>90 DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras IP20 protection
11	Spot PC Light / Spot Fresnel Lights	Power supply: 200-240V, 50Hz Power consumption: 1000W Colour temperature: 3200K, CRI>90 DMX 512 Dimming Linear Dimming from 0 – 100% Flicker free 100% for TV & Film cameras IP20 protection
12	Flood Light	Material: die-cast aluminium Diffuser: toughened glass Surface treatment: UV resistant powder coating Accessories: Stainless steel fasten parts, waterproof and durable silicone rubber gasket, Lamp source: Metal Halide 1000W Protection class:IP65
13	Footlight	Minimum 6W Super bright LED buried light skirting the Footlight
14	LED Foot light	Minimum 5 watt with DC supply 12 Volt Adaptor control
15	LED Strip Light	Waterproof LED flexible strip light with 12V DC power supply
16	Ceiling Light	2x2 square panel lighting LED, Cool White 6500K, >100 lumen/ Watt output
17	Mini Spot Light	3W to illuminate front stage from proscenium

Sr. No.	Type of Light Fixture	Description
18	Dual Red LED Step Light	For treads of steps or aisles (pathways). applications Voltage: 12V Lamp Type: LEDs Construction: Aluminum Extrusion Wiring: Parallel Wiring Mounting
19	LED Spot Light	2W, Warm White, Aluminium body
20	Emergency lighting / Exit signages	Emergency lighting is essential in auditorium. It should be ensured that all aisle lights, lights for steps and lights provided at the rear of the seating area are connected to the emergency circuit. Besides, exit lights should be provided at every access to guide the audience towards the exits in the event of a power failure.
21	General Lighting for Auditorium	Dimmable type downlighter, IP 20, CRI>=80, 3200K Colour temperature

Note: Design criteria and technical specification for other areas like lobby, corridor, staircase, toilets etc. are covered under section- INDOOR & OUTDOOR LIGHTING SYSTEM.

20. Light Controller

a. High end DMX Controller 48 Channels
   48 Channel Sliders
   96 Scenes/Chases Can Be Stored
   Up To 999 Chase Steps
   Blackout and Full-on Buttons
   Music Sensitive Playback

b. Light controller DMX splitter 8C: DMX splitter is a DMX512 distribution amplifier it is specially designed for connection of DMX receiver (dimmers, color changers, move lights, etc) in a star configuration. DMX splitter can surmount the restriction that single RS485 can only connect 32 sets of equipment. The multiple output optically isolated DMX512 distribution amplifier have become necessary in many DMX512 system. DMX splitter provides total electrical ground isolation between different branches of the stars. This greatly decreases problem with ground loops.

21. Waterproof IP67 LED Step Light Driver

Transformer 100-Watt 12V LED Power Supply suitable for 12V LEDs application to protects them from line voltage fluctuations, or for any other 12Volts DC electrical device. The 100-watt power converter shall provide a safe and effective way for users to tap into and utilize 100-277 Volt AC power sources and convert this current to 12 Volts DC for use with equipment that requires 12-volt electrical power. The power converter shall be an IP67 rated waterproof design, making it suitable for indoor or outdoor use and include integral short circuit and overload protection that will shut down the unit in case of faults and overloads to protect the unit and connected equipment from damage.

GENERAL REQUIREMENT FOR LED LIGHT FIXTURES

- All LED luminaires shall be provided with toughened glass and shall have thickness of sufficient strength and high efficiency prismatic diffuser under the LED chamber to protect the LED and luminaries.

- Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution for LED

- The fixture shall be designed so as to have lumen maintenance of at least 70% at the end of 50,000 hours (L70) at design temperature of 35-degree C & CRI=>90
- Lighting Colour temperature shall be 3200K ideal for performance with RGBW Colour mixed LED Lights
- Adequate heat sink with proper thermal management shall be provided.

- Minimum view angle of the LED shall not be less than 120 degree.

- Power factor of complete fitting shall be more than 0.95 at full load 240V and THD<8%.

- The LED luminaire shall be free of glare.

- The luminaire should be an inbuilt surge protection of not less than 4 KV to prevent in damage to the driver in case of sudden voltage surge.

- All light fixtures shall have fuse & internal safety protections.

- All surfaces of the luminaire / control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.

- The housing shall be extruded aluminium natural anodized finish with high efficiency diffuser and LED mounted on PCB with integral electronic driver.

- The finish of the luminaire shall be such that no bright spots are produced either by direct light source or by reflection.

- Each luminaire shall have a terminal block suitable for loop-in, loop-out and T-off connection by 1100 V, 1 core, PVC insulated copper conductor wires up to4 sq.mm in size.
- All metal or metal enclosed parts of the luminaire / control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.
- All light fixtures shall be sleek & unique designed light weight body.

PERFORMANCE

A high-quality lighting system has been proposed. The performance of the system after installation must meet the following specifications:

- Insulation resistance of lighting circuits not less than 20 Megohm.
- No audible RFI when tested with a portable AM/FM receiver.
- No interference in audio or video circuits at any dimmer setting.
- Complete system control to be demonstrated for all functions.

TESTS AND TEST REPORTS

- Type tests, acceptance tests and routine tests for the lighting fixtures and accessories covered by this specification shall be carried out as per the relevant standard for the respective fixtures and their accessories.

- The MANUFACTURER's type and routine test certificates shall be submitted for tests conducted as per relevant standards for the fixtures and accessories. The contractor shall submit with his proposal copies of available test certificates of the luminaires offered.

DRAWINGS AND DATA

- As part of proposal, the contractor shall furnish relevant descriptive and illustrative literature, performance characteristics for lighting fixtures and accessories and the following drawings / data for the respective lighting fixtures.
- Dimensioned drawings with manufacturer's catalogue numbers.
- Table showing manufacturer's catalogue number & images for luminaires
- Information called for in Data Sheet-B for each group of luminaires.
- Manuals and instructions for installation, operation and maintenance of all equipment and the stage lighting system. Minimum of three sets of such manuals and instructions are required for each equipment, to be furnished in bound volumes.

SPARE PARTS

The spare items for five years of operation as per manufacturer's recommendation shall be part of this contract.

15. SENSORS FOR ENERGY SAVING

Following sensors shall be provided for the indicated applications:

16. EARTHING SYSTEM

SCOPE

Sr. No	Description	Application
1	**Astro Time Switch – For Lights On-Off based on Sunrise and Sunset Timing** Supply, Installation, Testing and Commissioning of Astro-time switch based on Astro program i.e. calculation of sunrise and sunset times through date, time and Indian PIN Codes. It shall have an option of Astro ON period override by time switch and Offset function which allows programming of switching times offset from the astronomic time. The 230 V AC operated Astro Time switch shall have an operating range of 96…253V AC with 1 NO, 16 A, $AgSnO_2$ Contact material with Starting current of 120A and 1 CO cadmium free contacts, it shall have LCD status indication with back light display along with internal easily replaceable battery on the front side for set-up and programming. The electrical life at rated load AC1 shall be 1 Lakh cycles and shall work at an ambient temperature of -20 to +50 deg C. It shall have a dielectric strength between supply and open contacts of 4000V AC, between open contacts 1000V AC respectively and rated impulse voltage (between supply and contacts) of 10kV and rated impulse voltage (between open contacts) of 1.5kV. The mounting shall be on 35 mm DIN rail (EN 60715) and shall have necessary approvals like CE, IMQ and EAC.	These Timers are mounted inside the Feeder panels of the Outdoor Lights and are used for Energy Saving of internal parking area lights and street lights by switching the lights ON and OFF according to the Sunrise and Sunset time of the region with respect to the time of the year.
2	**PIR Movement and Presence Detector – For Corridors, Common Rooms, Stair Cases, Store Room, Washroom** Supply, Installation, Testing and Commissioning of 230 V AC operated movement detector shall have an operating range of 96…253V AC with 1 NO, 10 A, $AgSnO_2$ Contact material with starting current of 100A and shall have universal mounting position to permit the selection of any area of survey with IP 40 protection. It shall have an ambient temperature range of -30 to +50 deg C. Detection motion speed of 0, 6-15m/s. The Movement Detector shall have a dielectric strength between open contacts of 1000V AC with an electrical life at rated load AC1 of 1 LAKH cycles with necessary approvals like CE, EAC and IMQ. To be of Dual Mounted Type (wall and surface mounted) with the angle of survey shall be 120 degree / 360 degree, it shall have ambient light intervention threshold of 10 lux - 2000 Lux. With adjustable light ON time after last detection of 5 sec - 8 min,	It is applied for Indoor Areas such as Corridors, Staircases, Common Rooms, Store Rooms, Conference Rooms, Officer Cabins, Big Sitting Rooms, Workstation area to switch ON the Electrical Loads like Lights, A/Cs, Heaters, Fans only when there is someone present in the same, thereby saving energy.

This specification covers supply, design, installation, commissioning & testing of items required for earthing system including grounding conductors, rods, fittings, accessories and hardware to permanently and effectively ground the neutral points of transformers/ DG Sets, electrical apparatus, electrical equipment frames, conduit, cable trays and all non-current-carrying metal parts, including structural steel and fences.

The equipment shall be complete with all necessary accessories and components as required as per IS standard and PWD requirements.

GROUNDING SYSTEM

GENERAL REQUIREMENTS

The design of the equipment shall meet the following requirements:

It should provide means to dissipate the current into the earth during normal and fault conditions without exceeding the operating and substation equipment limits and connections.

The ground grid shall provide least resistance path for grounded neutral circuits.

The ground grid shall provide means of discharging current carrying parts which are to be handled by personnel.

Grounding consists of all conductors, ground rods, connectors and all other necessary items to make a complete grounding system.

The Contractor shall finalize the layout of the grounding system as required for the final equipment dimensions and locations.

The ground grid shall be designed so as to provide a maximum ground resistance of 1.0 ohm or less or as per local requirements.

Ground grid shall be installed at a minimum depth of 600 mm from ground level.

Earthing of transformers will be done separately through plate electrodes & further connected to the main collector network using connectors/ risers.

Where the ground conductor crosses the cable/ pipe trenches, the conductor shall be suitably lowered so as to cross cable trench at least 150 mm below its bottom surface.

Risers shall be brought out above the ground level for further extension and connection to equipment.

All conductors in the ground grid shall be welded together at every crossing and at every point where from risers emanate. Continuous lap welding shall be done instead of tack welding.

The risers from the grid shall be laid to avoid contact with reinforcement to guard against false grounding during resistance tests.

All non carrying current metal parts of electrical equipment and apparatus shall be earthed with two separate diametrically/ diagonally opposite connectors. The apparatus shall include:

(a) Bodies of electrical machinery, transformers etc.
(b) Frames of panels and cubicles
(c) Metallic structures of switchgear, casing of cable boxes
(d) Shielding of cables and electrical wiring conduits

17. LIGHTNING PROTECTION SYSTEM

GENERAL

Supply & installation of Lightning Protection System shall be strictly in accordance with IEC: 62305-2010.

ZONE OF PROTECTION

The zone of protection of a lightning conductor defines the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle called as protective angle.

MATERIAL AND DIMENSIONS

The materials of lightning conductor, down conductors, earth termination etc. shall be copper / GI as per schedule of quantities and shall be protected against corrosion.

All air terminations and down conductors shall be of copper / GI as per schedule of quantities and shall conform to IS/IEC: 62305-2010.

Joints and Bonds

The lightning protective system shall have as few joints as far as possible. Wherever joints in the conductor are necessary they shall be mechanically and electrically effective, and shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner.

Earth Terminations

Each down conductor shall have an independent earth termination. All the earth termination shall be inter-connected and shall be capable of isolation for testing.

Earth Electrode

Earthing with GI plate electrode will be used.

Down Conductor

In order to reduce probability of damage it is often necessary to have several parallel current paths. As recommended by IS/IEC: 62305-2010 equal spacing of down conductors, 20 x 3 mm GI external strip, around the building perimeter

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated Earth pit shall be connected to the other earth pits in the earthing grid.

Alternatively, steel reinforcement can be used as down conductor in line with IS/IEC: 62305-2010.

Steelwork within reinforced concrete structures is considered to be electrically continuous, provided that major part of interconnections of vertical & horizontal bars are welded, clamped or overlapped a minimum of 20 times their diameter and bound or otherwise securely connected.

While using structural reinforcement as down conductor,

- Preferably outer columns which are straight from terrace up to the ground floor shall be used as down conductor. Steel bars in this column should be welded \ bolted with proper overlapping at every floor to ensure, proper continuity throughout.
- At ground level steel bars shall be taken out & welded \ bolted to the GI tape, and the tape will be carried out till the earthing pit at ground

- Also at terrace level steel bars will be taken out & to the connected to the Air terminal.

18. DIESEL GENERATOR SET

The equipment shall be complete with all necessary accessories and components as required as per IS standard for trouble free installation & operation.

The generator shall have output rating sufficient to evacuate the output of the engine at rated power factor over complete range of site ambient conditions.

The DG set shall be supplied with acoustic enclosure conforming to relevant standards.

The generator shall be capable of satisfactory continuous operation at rated kVA and power factor at any voltage from 90% to 110% and within a frequency range of 47.5 Hz to 52.5 Hz.

The generator shall have overload capacity as per applicable standards. The generator shall be capable of withstanding a three phase short circuit at generator terminals when operating at rated kVA and power factor, 5% over voltage and with fixed excitation for 3 seconds.

EARTHING

In DG equipment 4 point earthing system are to be considered out of which 2 points are for body earthing with GI strip and 2 point is for alternator neutral earthing with Copper strip.

PIPING

All other associated piping, valves and other item necessary for completeness of equipment shall be supplied by the contractor.

UNLOADING

Genset should not be lifted from engine and alternator hooks. These are designed for lifting individual items only. Normally, provision for Genset lifting is provided on base- rails. The Genset should be unloaded from base rail by lifting with proper Genset lifting tackle or nylon sling/steel rope of suitable capacity and crane so as to ensure no damage to oil sump, air cleaner, radiator pipes etc.

Genset should be covered with polyethylene or tarpaulin during installation to ensure that water does not enter inside.

Spreader bar/ spacer plate of suitable size may be required to avoid damages to Genset components.

DG set with Acoustic enclosures shall be provided with lifting hooks.

LOCATION

DG Sets with Acoustic Enclosure

DG sets up to 1000 KVA capacity are required to be supplied with acoustic enclosure as per CPCB norms. DG Set with acoustic enclosure shall preferably be installed outside the building (including terrace subject to structural feasibility) & location should be finalized in consultation with the Architect. However, DG set should be as near to the substation as possible i.e. as near to Essential LT Panel as possible. Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. In case, AMF/ Electrical panel has to be installed outside the acoustic enclosure,

location of room to house AMF/ Electrical panel should be decided in consultation with the Architect so that it shall be as near to the acoustic enclosure as possible. Specially, in case of connection through bus trunking, care should be taken for aesthetics.

Nominal ratings of DG Sets

DG Sets are normally available in following standard capacities:

(Ratings in KVA)

7.5	10	12.5	15	17.5	25	30	35	40	50	62.5
75	82.5	110	125	140	200	225	250	320	350	380
415	450	500	550	600	625	700	750	1010	1250	1500

Capacity output of DG Set should be specified in tender in terms of “Prime Power Rating at 0.85 load factor” as per Clause 13.3.2 of ISO-8528 (Part-1).

Climatic Conditions

The output of DG Set shall be specified in tender documents under actual site conditions. The tenderer has to certify that the engine & alternator meets the capacity requirement after de-ration as per IS/ BIS.

DG Set upto 1000 KVA capacity should be type tested for Noise and Emission norms/standards as per CPCB.

DIESEL ENGINE

Engine Rating

The engine shall be of standard design of the original manufacturers. It should be 4 stroke cycles, water cooled, naturally aspirated/ turbo charged (as per manufacturer standard), diesel engine developing suitable BHP for giving a power rating as per ISO 8528- Part-1 in KVA at the load terminals of alternator at 1500 rpm at actual site conditions.

The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 (85%) for prime power output.

The engine shall conform to IS: 10000/ ISO 3046/ BS:649/ BS 5514 amended up to date.

Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacity up to 1000 KVA, should be furnished from the manufacturers along with the technical bid. However above 1000 KVA DG set, manufacturers shall furnish certificate that the Engine for the DG set complies with the CPCB Emission norms.

The engine shall be fitted with following accessories subject to the design of the manufacturer:

- Dynamically balanced Fly wheel
- Necessary flexible coupling and guard for alternator and engine (applicable only for double bearing alternator)

- Air cleaner (dry/ oil bath type) as per manufacturer standard,
- A mechanical/ electronic governor to maintain engine speed at all conditions of load.
- Daily fuel service tank of minimum capacity as per Table below, fabricated from M.S. sheet with inlet, outlet connections air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filters and fuel injectors. The location of the tank shall depend on standard manufacturers design.

RECOMMENDED MINIMUM CAPACITY OF DAILY FUEL SERVICE TANK

1.11.1.5

1.11.1.6

1.11.1.7

1.11.1.8

1.11.1.9

S.No.	Capacity of DG set	Minimum Fuel Tank Capacity
(i)	Upto 25 KVA	100 Litres
(ii)	Above 25 to 62.5 KVA	120 Litres
(iii)	Above 62.5 KVA to 125 KVA	225 Litres
(iv)	Above 125 KVA to 200 KVA	285 Litres
(v)	Above 200 KVA to 380 KVA	500 Litres
(vi)	Above 380 KVA to 500 KVA	700 Litres
(vii)	Above 500 KVA to 750 KVA	900 Litres

1.11.1.10

a) Dry exhaust manifold with suitable exhaust residential grade silencer to reduce the noise level.

b) Suitable self-starter for 12 V/ 24 V DC.

c) Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals.

d) Necessary gear driven oil pump for lubricating oil, priming of engine bearing as well as fuel systems as per manufacturer recommendations.

e) Naturally aspirated/ turbo charger (as per manufacturer standard)

f) Lubrication oil cooler

g) Lubrication oil filters with replaceable elements

h) Crank case heater as per manufacturer recommendations

i) Fuel injection: Engine should have suitable fuel injection system in order to achieve low fuel consumption

j) Fuel control solenoid

k) Fuel pump with engine speed adjustment

l) Engine Control Panel: fitted and having digital display for following**:**

- Start/stop key switch
- Lube oil pressure indication
- Water temp. indication

- RPM indication
- Engine Hours indications
- Battery charging indication
- Low lub. Oil trip indication
- High water temp. indication
- Over speed indication

m) All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch any moving part.

n) Radiator/ Heat Exchanger System/ Remote Radiator(delete whichever is not applicable)

o) Any other item not included/ specified but is a standard design of the manufacturer

Governor

Mechanical governor of class A2 for up to and including 200 KVA capacity and Electronic governor of class A1 for capacity above 200 KVA, as per ISO 3046/ BS 5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self contained unit capable of monitoring speed.

Frequency Variation

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated frequency.

Fuel System

It shall be fed through engine driven fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing. The daily service tank shall be complete with necessary supports, gauges, connecting pipe work etc. In case of Top Mounted tanks, non return valves are must in fuel supply and return line of specified value. Pipe sealant should be used for sealing for all connections. No Teflon tape to be used. If piping length is more than 10 meters, detail engineering is required in consultation with OEM/ Manufacturers.

Lubricating Oil System

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Necessary priming pump for the lub. oil circuit as per recommendation of manufacturer shall be installed, to keep bearings primed. This pump shall be normally automatically operative on AC/ DC supply available with the set.

Starting System

This shall comprise of necessary set of heavy duty batteries 12V/ 24V DC (as per manufacturer standard), and suitable starter motors, axial type gear to match with the toothed ring on the fly wheel. A timer in the control panel to protect the starter motor from excessively long cranking runs shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempt starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 20-30 sec., even in winter condition with an ambient temperature down to 0°C.

Battery Charger

The battery charger shall be suitable to charge required numbers of batteries at 12V/ 24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs etc.

Piping Work

All pipe lines and fittings and accessories requirement inside the room/ enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust shall be used. For fuel lines within the acoustic enclosure, PVC braided pipe as per manufacturer recommendations can be used. However, for fuel lines outside the acoustics enclosure only MS pipe be used.

The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. The installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

Common Bed Plate

Engine and alternator shall be directly coupled or coupled by means of flexoplate/ flexible coupling as per manufacturer standard design and both units shall be mounted on a common bed plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The bed plate shall be suitable for installation on suitable anti-vibration mounting system.

Exhaust System: (wherever applicable)

Exhaust Piping: All M.S. Pipes for exhaust lines shall be conforming to relevant IS. The runs forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of exhaust pipe work using 50 mm thick Loosely bound resin (LBR) mattress/ mineral wool/ Rockwool, density not less than 120 kg/m3 and aluminium cladding (0.6 mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping. The exhaust pipe shall be *run along the existing wall of the building duly clamped/*supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer-in-charge.

Exhaust system should create minimum back pressure.

- Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.
- Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.
- Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along with aluminium sheet cladding / insulated to avoid heat input to the room.
- Exhaust flexible shall have it's free length when it is installed. For bigger engines, 2 flexible bellows can be used.
- For engines up to 500 KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.

- 'Schedule B' MS pipes and long bend/elbows should be used.
- The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.
- When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.
- When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

Optimum Silencer Location: Location of the silencer in exhaust system has very definite influence on both reduction of noise and back pressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in meters. Please note that locating the silencer as per optimum silencer location is not mandatory. For high rise buildings, suitable arrangements may have to be provided in consultation with acoustics engineer.

Optimum Location of Silencer (In meters)		
	In-line Engine	**'V' Engine**
Best	2L/5	(4L – 1.5) / 5
Second best	4L/5	(2L – 4.5) / 5
Worst Location of Silencer	L/5 or 3L/5 or at tail end of Exhaust piping	(3L - 10)/ 5 or at the tail end of Exhaust piping

Exhaust Stack Height: In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

- FOR DG SET UP TO 1000 KVA :-

  $H = h + 0.2 \times \sqrt{KVA}$

  Where H = height of exhaust stack h = height of nearby building

- *FOR DG SET ABOVE 1000 KVA :-*

  30 m High or 3 m above the building height, whichever is higher.

Care should be taken to ensure that no carbon particles emitted due to exhaust leakage enters and deposits on alternator windings and on open connections.

Support to Exhaust Piping: Exhaust piping should be supported in such manner that load of exhaust piping is not exerted to turbocharger.

Air System

It is preferable to provide vacuum indicator with all engines to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/ manufacturer recommendation for the particular model of the engine. Gensets should be supplied with medium duty/ heavy duty air cleaners (specify one only). (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.)

Cooling System

System should be designed for ambient temperature of 50 Deg.C.

Water softening/ demineralizing plants should be used, if raw water quality is not acceptable.

Coolant should be used mixed with additive (in suitable proportion) as per recommendation of OEM /Manufacturer for various engine models.

Radiator fan flow should be free from any obstruction.

For radiator cooled DG Set, proper room ventilation should be planned at the time of construction of DG room.

Remote Radiator can be used in case of basement installation where fresh air may not be available. The proper location of remote radiator is very essential for the successful and efficient operation of remote radiator. In this the cooling media is ambient air. So in order to obtain maximum efficiency from remote radiator, it is necessary to get fresh air in its surrounding. The horizontal distance of remote radiator from engine should not exceed 10 Meter.

For the dusty or polluted surroundings (as radiator gets clogged) and/ or bigger capacity Gensets (say 1000 KVA and above), installation of Cooling System with Heat Exchanger system may be used.

Optional items as under may be included as per site requirement at the discretion of Technical Sanctioning authority:

- COOLING SYSTEM
  - Remote Radiator
  - Jacket Water Heater
  - Crankcase Oil Heater
  - After cooler jacket turbo charger electrical pre heat systems.
- FUEL SYSTEM
  - Fuel Water Separator
  - Auxiliary Fuel Pump
- EXHAUST SYSTEM
  - Industrial Grade Muffler
  - Residential Grade Muffler
  - Critical Grade Muffler
  - Super Critical Grade Muffler
- START SYSTEM
  - Battery Warmer Plate
  - Battery Charger
  - Automatic Float Equalizing
  - Trickle

ALTERNATOR

Synchronous Alternator

Self excited, screen protected, self regulated, brush less alternator, Horizontal foot mounted in Single/Double bearing construction (specify one only) suitable for the following:

Rated PF.	:	0.8 (lag)
Rated voltage	:	415 volts
Rated frequency	:	50 Hz
No. of Phases	:	3
Enclosure	:	SPDP
Degree of protection	:	IP-23
Ventilation	:	Self ventilated air cooled
Ambient Temperature	:	50° C Maximum
Insulation Class	:	F/H
Temperature Rise	:	Within class F/H limits at rated load
Voltage Regulation	:	+/- 1%
Voltage variation	:	+/- 5%
Overload duration/capacity	:	10% for one hour in every 12 hours of continuous use.
Frequency variation	:	As defined by the Engine Governor (+/- 1%)
Excitation	:	Self / separately excited (Self excitation upto 750 KVA and separately excited system above 750 KVA)
Type of AVR	:	Electronic
Type of Bearing and Lubrication arrangement	:	Anti-friction bearings with Grease lubrication
Standard	:	IS 4722 & IEC:34 as amended upto date.

Alternator should be able to deliver output rating at actual site conditions.

The alternator above 500 KVA capacity shall be fitted with suitable Nos. Resistance Temperature Device (RTD) & Bearing Temperature Device (BTD) alongwith space heaters. The terminal of space heaters will be wired to terminal box and the temperature scanner shall be provided in control panel for scaling the winding and bearing temperature.

Excitation

The alternator shall be brushless type and shall be self/ separately excited, self- regulated having static excitation facility. The exciter unit be mounted on the control panel or on the alternator assembly. The rectifier shall be suitable for operation at high ambient temperature at site.

Automatic Voltage Regulators (AVR)

In order to maintain output terminal voltage constant within the regulation limits i.e.

+/- 1%, Automatic voltage regulator unit shall be provided as per standard practice of manufacturer.

Fault tripping

In the event of any fault e.g. over voltage/ high bearing temperature/ high winding temperature or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

Standards

The alternator shall be in accordance with the following standards as are applicable.

(i) IS 4722/ BS 2613: 1970. The performance of rotating electrical machine.

(ii) IS 4889/ BS 269 rules for method of declaring efficiency of electrical machine.

Performance

Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO 8528 (Part-1). The winding shall not develop hot spots exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1 of IS 4722:1992.

The performance characteristics of the alternator shall be as below:

- Efficiency at full load 0.8 P.F.
    - Upto 25 KVA – not less than 82%
    - Above 25 KVA and upto 62.5 KVA – not less than 86%
    - Above 62.5 KVA & upto 250 KVA – not less than 90%
    - Above 250 KVA – not less than 93.5%
- Total distortion factor Less than 3 %
- Overloading
    - 10% overload - One hour in every 12 hrs of continuous use.
    - 50% overload - 15 seconds.

Terminal Boxes

Terminal boxes shall be suitable for U.G. cables/ Bus Trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

Earth Terminals

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12 mm dia. hole shall be provided.

Space Heaters

Alternators of capacity more than 500 KVA shall be provided with suitable space heaters to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 V AC supply and a permanent caution notice shall be displayed.

MANUAL/ AMF PANEL, BATTERIES AND ELECTRICAL SYSTEM

Battery/ Electrical System

Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.

Batteries should be placed on stands and relatively at cool place.

Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2 m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2 V. However capacity as recommended by manufacturer may be taken.

DG Set Capacity	**Battery Capacity (AH)**	**Cable Size (Material Copper) Sq. mm**	**Electrical System (Volts)**
Above 500 KVA	360	70	24
Above 125 KVA upto 500 KVA	180	70	12
Above 82.5.KVA upto 125 KVA	180	50	12
Above 62.5 KVA upto 82.5 KVA	150	50	12
Above 25 KVA upto 62.5 KVA	120	50	12
Upto 25 KVA	88	35	12

For AMF applications, a static battery charger working on mains supply is recommended to keep the batteries charged at all times.

1.5 sq.mm copper wire should be used for wiring between junction box and Control Panel.

Cabling

Power cabling between alternator and control panel and control panel and change over switch to mains should be done with recommended cable sizes.

As far as possible, for DG Set of capacity 750 KVA & above connection between alternator to AMF panel & AMF Panel to Essential panel shall be through bus- trunking. For exposed/ outdoor bus trunking protection requirement should be IP-55.

If LT panel is part of tender of the DG Set jobs of 500 KVA & above, LT Panel specified, should be one of the reputed brands.

Overheating due to loose thimbling / undersize cables causes most of electrical failures, hence correct size of cable and thimbles should always be used, if cable is specified.

While terminating cables, avoid any tension on the bolts/ busbars (if cable is specified). While terminating R, Y& B phase notations should be maintained in the alternator and control panel for easy maintenance.

Crimped cables should be connected to alternator and control panel through cable glands, if cable is specified.

Multi-core copper cables should be used for inter connecting the engine controls with the switchgear and other equipments.

For AMF application, multicore 1.5 sq.mm flexible stranded copper cable for control cabling should be used.

It is recommended to support output cables on separate structure on ground so that weight of cables should not fall on alternator/ base rail.

External wirings, when provided for remote voltage / excitation monitoring/ droop CT etc. shall be screened sheathed type. Maximum length of such wiring shall not exceed 5 meters.

Alternator Termination Links

For proper terminations between links and switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

Point contact arising out of improper position of links with switchgear terminals.

Gaps between busbars / links and terminals being remedied by connecting bolt/stud. In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

Adequate clearance between busbars / links at terminals should be maintained (IS 4232 may be referred to for guidelines).

Improper termination will lead to local heat generation which may lead to failure.

FOUNDATION

Genset with Acoustic Enclosure

For DG Sets installed inside the DG Set Room - A PCC foundation (1:2:4, M-20 grade) of approximate depth 150 mm above the finished Genset Room Floor level is required so as to provide levelled surface for placement of the acoustics enclosure. The length and breadth of foundation should be at least 250 mm more on all sides than the size of the enclosure. Genset should be mounted on AVM's inside the enclosure.

For DG Sets installed outside in open area -APCC (1:2:4, M-20 grade) foundation of weight 2.5 times the operating weight of the Genset with enclosure or as recommended by the Genset manufacturer OEM/OEA, whichever is higher, is required to be provided and is included in scope of work for SITC of Genset. 300 mm of this foundation height should be above the ground level. The length and breadth of foundation should be at least 250 mm more on all sides than the size of enclosure. Genset should be mounted on AVM's inside the enclosure.

Genset without Acoustic Enclosure

Genset should not be installed on loose sand or clay.

Foundation should be designed considering safe bearing capacity of soil. Vibration isolators (AVMs) should be provided to reduce vibration transmission to the surrounding structure.

Depths of PCC (Plain Cement Concrete) for typical soil condition have been shown in the table below. However structural engineer should be consulted to verify the data depending upon soil condition.

DG Set Capacity (KVA)	Typical Depth of PCC Foundation (For soil bearing capacity 5000 kg/sqm)
750-2000	600 mm
625	400 mm
320-500	400 mm
200-320	400 mm
82.5 -200	400 mm
Upto 82.5	200 mm

Foundation level should be checked diagonally as well as across the length for even flatness. The foundation should be within ± 0.5 Degree (angle) of any horizontal plane.

ACOUSTIC ENCLOSURE

Installation

Acoustic enclosures are supplied with built in Anti Vibration Mountings (AVMs). As such Genset can be installed directly on the leveled surface.

Exhaust piping outlet should not be turned towards window / ventilator of home or occupied building. Provision of rain cap should be ensured.

The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

Service Accessibility

Genset / Engine control panel should be visible from outside the enclosure.

Routine / periodical check on engine / alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure.

For major repairs / overhaul, it may be required to dismantle the acoustic enclosure.

Sufficient space should be available around the Genset for inspection and service.

General Design Guidelines

To avoid re-circulation of hot air, durable sealing between radiator and canopy is must.

Ventilation fans are must for the Gensets cooled by heat-exchanger/cooling tower system.

Exhaust piping inside the enclosure must be lagged (except bellow).

Temperature rise inside the enclosure should not be more than 5°C for maximum ambient above 50°C and it should be below 10°C for ambient below 50°C.

There should be provision for oil, coolant drain and fill. Fuel tank should have provision for cleaning.

The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recommended by the engine manufacturer.

Specifications for Acoustic Enclosure

The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for outdoor installation exposed to weather conditions, and to limit overall noise level to 75 dB (A) at a distance of 1 mtr. from the enclosure as per CPCB norms under free field conditions.

The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall conform to the details as under:

The enclosure shall be fabricated out the CRCA sheet of thickness not less than

1.6 mm on the outside cover with inside cover having not less than 0.6 mm thick perforated powder coated CRCA sheet.

The hinged doors shall be made from not less than 16 SWG (1.6 mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.

All sheet metal parts should be processed through 7-tank process.

The enclosure should be powder coated.

The enclosure should accommodate the daily service fuel tank of the D.G. Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running. The gauge should be calibrated. The fuel tank should be filled from the out side as in automobiles and should be with a lockable cap.

The batteries should be accommodated in the enclosure in battery rack.

The canopy should be provided with high enclosure temperature safety device.

The acoustic lining should be made up of high quality insulation material i.e. rockwool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturer's to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated M. S. Sheet duly powder coated / GI sheet/ aluminium sheet.

The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose. Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance & repairs.

The canopy should be as compact as possible with good aesthetic look.

The complete enclosure shall be of modular construction.

The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start

arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G sets.

The acoustic enclosure should be suitable for cable connection/connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof conforming to IP-65 protection.

The inside of enclosure should be provided with at least two nos. 15 W-LED light luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all conditions.

SPECIFIC REQUIREMENTS OF DG PANEL

General operation philosophy

No volt relays provided in the Main LT panel / DG controller will monitor the grid voltage. In the event of grid supply failure Controller will trip the grid incomer breakers and also give initiating signal to DG for auto starting. For this DG Local / Remote/Test mode selector switch is in Remote mode and DG Auto/Manual selection shall be selected for Auto.

One or multiple DG sets shall start automatically as per the philosophy / sequence. After build up of voltage and speed (Voltage >80% and Engine speed reached to rated speed), incoming breaker of first DG set (Master) will close automatically on dead bus provided the lockout relay of DG breaker is reset. If DG breaker fails to close on AUTO, provision shall be made to close the same manually from DG panel. The other DG incomers (Slave) will close on Live bus synchronising as per load requirement which will be monitored by DG Controller.

Line PT's, Bus PT and Auto / Manual synchronising facility shall be provided. Outgoing breaker(s) of DG panel / incomer breakers of Main LT panel as applicable will close on auto as per the philosophy and power will be extended up to the bus of Main LT panel

On restoration of grid supply, the changeover scheme from DG supply to Grid supply shall be as per the philosophy defined in SLD.

In the AMF starting sequence, facility for minimum number of starting attempts shall be as indicated in Data Sheet. In case DG fails to start and reach rated speed within 90 seconds, it shall be disconnected and locked out automatically. A hand reset lockout relay shall be provided with suitably wired contacts such that it prevents starts in quick succession in excess of the number.

DG Controller shall perform the following function:

a) Automatic starting, load sharing and stopping of DG sets based on variation in load

b) There should be facility in panel to test the DG Sets.

Facility for remote alarm indication for "AMF set in operation", "AMF fails to start" shall be provided through potential free contact.

The DGs will not run in parallel with State electricity board grid. There could be momentary paralleling of about 30 to 60 Seconds during changeover as per the philosophy.

Separate numerical relay for IDMT over current and earth fault i.e. 51 & 51N protection shall be provided. Relays should have RS485 port at front side. Relays and protection shall be enabled for SCADA/BMS compatibility with IEC 61850 protocol.

Generator protection relays shall be supplied with latest version software and hardware without any extra cost. It should be possible to set relay, view fault parameters, download information from relay to computer connected system.

For DG incomer(s) separate master trip relay '86' (VAJHM23), trip circuit supervision relay '95' (VAX31) shall be provided. These shall be separate electromechanical relays and not as element of numerical relay.

DG Set Controller shall be considered for integration with SCADA/IBMS.

DG controller shall be suitable for single genset operation as well as multi- genset operation which includes Island operation, Fixed power/ base load, AMF & ATS, peak shaving, Load takeover, AMF mode.

The DG controller shall be a part of DG panel. DG controller shall have following minimum inbuilt electrical protections:

- Reverse power (32)
- Short Circuit (50P/N)
- Overcurrent (51)
- Negative phase sequence(46)
- Unbalance Protection (47)
- Under/ Over Voltage (27/59)
- Under / Over Frequency (81R/81O)
- DG controller shall have following minimum engine side protections:
- Overspeed / Under speed shutdown
- Low/ High Battery Voltage
- Battery test alarm
- Fail to Crank shutdown
- Cranking lockout
- Incomplete start after a preset time
- Low fuel warning / shutdown
- Jacket water high temperature
- Low lube oil Pressure after the DG has attained 90% speed
- DC control supply failure
- Engine trip due to generator fault

- One Annunciator with Test, Accept, Reset & Mute push button and hooter along with following annunciations shall be provided for incomer feeder : Auxiliary voltage for the window type annunciation system shall be derived from the battery
- Engine fails to start
- DG on load test
- Engine trip due to generator fault
- High jacket water temperature
- High lube oil temperature
- High differential pressure across lube oil filter
- Bearing temp. High alarm
- Winding temp. High alarm
- Emergency DG stop
- Starting air pressure low(if applicable)
- Diesel level low indication
- Diesel level high indication
- Low lube oil pressure and trip of the engine
- High water temperature (if applicable)
- Engine over-speed and trip
- Engine / Alternator common fault
- Multifunction relay (51, 51N) operated
- Lube oil priming pump (if provided) in operation
- Voltage out of limit
- Ground fault in the system
- AC/DC control supply failure
- DG is paralleled with the main source (grid)
- Battery fully discharged
- Charger failure
- Spare (4 Nos.)

The below mentioned signals shall also be provided as potential free contacts for remote annunciation.

- DG over load
- DG trouble (group annunciation)
- Engine failed to start
- Engine ON
- Engine tripped on fault
- R, Y, B indication lamps, Local/Remote selector switch, Auto/Manual selector switch, Voltage Raise/Lower, Speed Raise/Lower selector switch, Lamp test push button, Emergency trip push button shall be considered for incomer. Trip shall be independent of local/remote.
- Incomer of panel shall be provided with analogue ammeter with ammeter selector switch, analogue voltmeter with voltmeter selector switch, analogue kW meter.
- Multifunction meters (MFM) shall be provided for all incomers/outgoing feeders.
- Looping of all RS485 ports shall be done using 3 cores twisted & shielded 1.5 sq.mm Cu cables and shall be terminated at incomer

The DG panel shall also consist of but not limited to the following:

- One (1) 45-55 Hz frequency meter (Digital type).
- DC voltmeter for battery to read battery voltage if charger is part of DG Panel
- Necessary MCBs for distribution of voltage as required for all control, interlocking and annunciation system
- Two (2) push buttons for starting and stopping the DG set.
- 1 no. temperature scanner to monitor the temperature of alternator stator winding and temperature of bearings
- Necessary MCCB for receiving 415V power supply from EMPLOYER's switchgear to the battery charger unit. if charger is part of DG Panel
- Three (3) single phase voltage transformers (VTs) 415/ 3 / 110/ 3 volts for metering & synchronisation. The VTs shall be connected in star/star with neutral earthed. The rated VA burden of the VTs shall be minimum 50 VA for each single phase. The VT's shall be provided for each DG incomer and also for the bus.
- Necessary voltage relays
- DG Local/Remote /Test selector switch
- Auto synchroniser
- Synchronising relay for manual synchronisation

- Double volt meter and frequency meter for synchronisation
- Synchronoscope
- Synchronising mode selector switch for Auto/Manual
- Synchronising selector switches
- Auxiliary relays and timers as required for control, interlocking, annunciation system, contact multiplication shall be provided. All relays and timers shall be of reputed make
- One (1) trip relay for alternator faults and one (1) trip relay for engine faults shall be provided to trip the DG breaker on occurrence of either engine or alternator faults
- AVR shall have a motorised potentiometer with facility to control the excitation from AMF panel. Suitable equipment to facilitate operation from AMF panel shall be provided.
- Semi conductor based float cum boost charger shall be considered in DG panel.

Spare parts

The BIDDER shall furnish a list of recommended spare parts for five years operation along with unit prices.

Tests and Reports

Type test reports for the switchgear panel of similar rating for the following tests shall be submitted along with the Bid (not older than 5 years):

Temperature rise

Degree of protection

Internal arc with make of components being offered

Short circuit

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out. Type tests shall also be carried out if not tested previously.

Type and routine test report shall be submitted for the EMPLOYER's approval before the equipment is dispatched. Bound copies of test reports shall be furnished along with the switchgear.

Inspection by EMPLOYER/ Engineer will not be carried out unless the Vendor confirms that calibrated equipment are ready for proceeding with the tests

Equipment shall not be dispatched unless the test certificates are duly approved by the EMPLOYER/ ENGINEER.

Vendor shall carry out all routine tests as specified in relevant IS/ IEC standards on all major components and furnish copies of test reports for EMPLOYER's approval. Wherever required,

Vendor shall conduct the necessary type tests in the presence of EMPLOYER's representative based on the unit prices available in the bid.

Vendor shall also carry out all routine and functional tests as specified in the relevant IS/IEC on the assembled switchgear panels in the presence of the EMPLOYER's representative at works before despatch and furnish copies of test reports for approval. If required stage inspection, will be carried out by the EMPLOYER

VENDOR shall furnish copies of routine test report for all bought out items for EMPLOYER's approval.

DRAWINGS AND DATA

The following shall be furnished as part of the tender:

General arrangement showing plan, elevation and typical sectional views.

Technical literature on the equipment offered

Quality Assurance Plan.

MAINTENANCE REQUIREMENTS

Easy access shall be provided for all components in the switchgear for maintenance.

As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Bidder shall include price of one complete set in his bid.

The Bidder shall recommend spares for three (3) years trouble free operation.

Vendor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to enable the EMPLOYER to carry out maintenance work.

TECHNICAL DATA SHEET

S.No.		RATING	ATTRIBUTE
1.0	DESIGNATION		DG Set
2.0	NUMBER REQUIRED		As per SLD
3.0	TAG NUMBERS		*
4.0	TYPE : MANUALLY STARTED / AUTO MAINS FAILURE (AMF)		Auto Mains Failure (AMF)
5.0	FUEL AS PER IS 1460		High Speed Diesel (HSD)
6.0	SITE CONDITIONS:		
6.1	ALTITUDE - ABOVE MEAN SEA LEVEL	M	*
6.2	MAXIMUM AMBIENT TEMPERATURE	°C	50
6.3	RELATIVE HUMIDITY	%	90 (Max)
7.0	RECIPROCATING INTERNAL COMBUSTION ENGINES - BS 5514/ISO 3046 PARTS 1,3,4,5,6 &7		Yes
8.0	MACHINES FOR MISCELLANEOUS APPLICATIONS - BS 5000 PART 99		Yes

S.No.		RATING	ATTRIBUTE
9.0	ROTATING ELECTRICAL MACHINES - IS 4722		Yes
10.0	CONTINUOUS OUTPUT AT SITE CONDITIONS	KW	*
11.0	OVERLOAD CAPABILITY FOR ONE (1) HOUR IN TWELVE (12) CONSECUTIVE HOURS OF OPERATION		10%
12.0	RATED VOLTAGE		433 V
13.0	RATED FREQUENCY		50Hz
14.0	NUMBER OF PHASES		3
15.0	POWER FACTOR (PF)		0.80
16.0	WINDING CONNECTION		Star with neutral earthed through resistor and isolator
17.0	TYPE OF INSULATION:		
17.1	ARMATURE WINDINGS		Class F
17.2	FIELD WINDINGS		Class F
17.3	COMMUTATOR		Class B
17.4	CORE CONNECTION		Class B
18.0	TYPE OF ENCLOSURE		IP 54
19.0	PERMISSIBLE VOLTAGE VARIATION AT RATED KVA, SPEED AND PF	%	+/- 10%
20.0	TRANSIENT REACTANCES:	%	
20.1	X' d:		*
20.2	X'' d:		*
21.0	PERMISSIBLE FREQUENCY VARIATION AT RATED KVA, SPEED AND PF	$\pm$ %	+/- 5%
22.0	METHOD OF NEUTRAL GROUNDING: SOLIDLY EARTHED **/** THROUGH NGR		Solidly Earthed
23.0	LARGEST MOTOR TO BE STARTED WITH DROP IN THE GENERATOR TERMINAL VOLTAGE LESS THAN 15% WITH FULL BASE LOAD		
23.1	DOL /STAR DELTA	KW	*
23.2	REDUCED VOLTAGE	V	*
24.0	PARALLEL OPERATION		
24.1	IF MORE THAN ONE DG IS IN OPERATION, WHETHER IN ISOLATION/ IN PARALLEL		NA
24.2	DG IN PARALLEL WITH THE GRID CONTINUOUSLY	YES/NO	No
24.3	DG IN PARALLEL WITH THE GRID MOMENTARILY	YES/NO	No
24.4	ARE UNDERFREQUENCY LOAD SHEDDING SCHEMES REQUIRED IF YES:	YES/NO	No
24.4.1	TYPE OF UNDER FREQUENCY RELAY		
24.4.2	LOAD SHEDDING REQUIREMENTS		
24.4.3	PROTECTION REQUIREMENTS		

S.No.		RATING	ATTRIBUTE
25.0	HARMONIC LOADING (IF ANY): CURRENT-	%THD	*
26.0	SIZE OF CONDUCTOR CABLES	C x mm^2	*
27.0	PERIOD FOR TAKING LOAD FROM 'START' IMPULSE	sec	*
28.0	COOLING WATER /MAKE-UP WATER QUALITY:		*
28.1	COOLING WATER INLET TEMPERATURE	°C	*
28.2	MAXIMUM ALLOWABLE COOLING WATER TEMPERATURE RISE	°C	*
28.3	COOLING WATER INLET PRESSURE	kg/cm2 (g)	*
28.4	MAXIMUM ALLOWABLE COOLING WATER PRESSURE DROP	kg/cm2	*
29.0	ENGINE STARTING SYSTEM : COMPRESSED AIR / ELECTRIC		Electric
30.0	BATTERY AND BATTERY CHARGER	YES/NO	Yes
31.0	EXCITATION SYSTEM : STATIC / BRUSHLESS		Brushless
32.0	MANUAL START/STOP OF ENGINE THROUGH LOCAL / REMOTE PUSH BUTTON REQUIRED	YES / NO	Yes
33.0	TRIP DEVICE ON MAIN SUPPLY RESTORATION REQUIRED	YES/NO	Yes
34.0	STOPPING OF DG SET: MANUAL/AUTO		MANUAL/AUTO
35.0	GOVERNOR CLASS : A1 / A2		A1
36.0	RESPONSE TO STEP CHANGE OF LOAD: SWITCH-IN AND/OR THROW-OFF		*
37.0	SPEEDERGEAR OPERATION ON DC VOLTAGE FOR REMOTE VARIATION OF SPEED REQUIRED	YES / NO	No
38.0	MAXIMUM TIME OF OPERATION WITHOUT COOLING WATER AVAILABILITY DURING START UP	Min	*
39.0	GENERATOR SWITCHGEAR BY CONTRACTOR / EMPLOYER		*
40.0	MOTORS : BY CONTRACTOR / EMPLOYER		*
41.0	ENGINE COOLING SYSTEM : WATER COOLED HEAT EXCHANGER / RADIATOR WITH ENGINE DRIVEN FAN		Radiator type
42.0	COOLING TOWER: BY CONTRACTOR/ EMPLOYER		*
43.0	COOLING WATER PUMPS: BY CONTRACTOR/ EMPLOYER		*
44.0	COUPLING AND COUPLING GUARD	YES/NO	Yes
45.0	EXHAUST PIPE/ STEEL STACK	YES/NO	*
46.0	TACHO GENERATORS	YES/NO	*

S.No.		RATING	ATTRIBUTE
47.0	AC MOTOR DRIVEN PRIMING OIL PUMP WITH CLOCK TIMER	YES/NO	*
48.0	BATTERY VOLTMETER	YES/NO	Yes
49.0	WINDING AND BEARING RTDs FOR GENERATOR	YES/NO	*
50.0	ENGINE COUPLED WITH GENERATOR		
50.1	ONE (1) HOUR AT 50% LOAD		*
50.2	ONE (1) HOUR AT 75% LOAD		*
50.3	FOUR (4) HOURS AT FULL LOAD		*
	FOLLOWED BY ONE (1) HOUR CONTINUOUS LOAD OF 110%		
51.0	GENERATOR		
51.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes
52.0	EXCITER		
52.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes

19. DG SYNCHRONISING PANEL

SCOPE

This section covers synchronization of DG sets as required and comprises of running of DG set in parallel, i.e., their synchronization on common bus bar, auto load sharing and auto load management. The panel fabrication, breakers, bus bar requirements shall be as per other outdoor LT Panels in addition to the following requirements.

PLC PANEL

Operation of DG sets shall be monitored and controlled by PLC panel, i.e., Programmable Logic Controller based logic panel. In case of mains failure, this logic panel shall control auto changeover from mains to DG sets supply and interlocking of ACBs, auto synchronizing and auto load management functions along with annunciation for alternator control and protection.

The logic panel shall be provided with a total manual over ride facility. There shall be smooth transfer of DG set operation from PLC to manual system & vice versa without any interruption/ tripping. The logic panel shall be complete with all auxiliary relays, timers, contactors, programmable logic controller, control wiring, interconnections etc with 2.5 mm^2 PVC insulated, 1.1 kV grade copper conductor wires.

CONTROL PHILOSOPHY

Automatic start & stop of engine

The system should come in operation after sensing of grid failure and automatically control the start & stop engines, depending on the predefined load setting in the PLC. In case engine does not start in the first cranking, two more auto commands should be given with proper intervals. Even then if engine fails to start, indication must appear on MMI (Man Machine Interface). In the event the engines are under loaded, i.e. load sensed is capable of being catered by less than the capacity of running DG sets then command must be given to stop the required number of excess

DG sets after running idle for short duration. Provision to select no of DG sets to be started and synchronized at no load to cope up with sudden load without tripping the DG's should also be inbuilt into the system.

Automatic Synchroisation

The facility of synchronisation will be available in both Auto & Manual mode. In normal circumstances the auto synchronisation will work, however if due to any reason auto synchronisation fails repeatedly the facility for closure of ACB must be available automatically. In manual mode ACB will be closed by panel push button.

Automatic Load Sharing

The load sharing will also be automatic, by sensing both active & reactive power.

Back up Protection

The system should also have following inbuilt protection other than external relays in synchronization panel:

Reverse power, Reverse kVAR, Over Current, Under voltage, Over voltage, Under frequency, Over frequency, synchro-check & earth fault relay except differential relay. Due to any electrical fault PLC shall trigger the master trip relay.

These PLCs will be state of the art equipments using latest technology and of most rugged and reliable design. Since they shall be operating in the harsh & unfriendly environment of DG room, they will be suitable to operate trouble free in those conditions. The chosen equipment should be able to withstand high temperature, humidity & voltage fluctuations, thus making it suitable for the operating conditions described above.

Sequence of operation

The following sequence of operation shall be achieved through PLC based logic panel in addition to hardware interlocks as well as software interlocks:

(i) Selection of any generator as a lead generator to achieve the uniform running hours of all generators.

(ii) Three attempts to start the engine of lead generator. In case the engine fails to start or does not achieve the requisite speed within the predetermined time, PLC system declares engine of generator faulty. In this event PLC automatically selects next generator as the lead generator.

(iii) The PLC system automatically selects starting sequence of other generators on the basis of the lead generator being selected by the operator.

(iv) Before issuing close command to lead generator air circuit breaker, PLC checks that ACB of any other generator is not in close position. Then PLC system gives close command to lead generator ACB. The PLC system tries two times with interval of 5s to close the ACB. Simultaneously, it also gives starting command to next generator engine in queue depending upon load.

(v) The speed, excitation, frequency and voltage of incoming generator is controlled identically as per the lead generator starting sequence described above, except closing of ACB.

(vi) When the lead generator kW crosses more than the 85% of rated capacity of DG set, the PLC system performs synchronization sequence for paralleling of generator prior to switching on of the ACB of 2nd generator.

(vii) The last incoming generator ACB is tripped when PLC system senses that the total load on the system is less than the specified load and stops the engine after 5 minutes of idle running.

(viii) DG sets will start and stop automatically depending on the pre defined load setting in the PLC & also all DG sets will operate in load sharing mode.

ACOUSTIC ENCLOSURE

Installation

Acoustic enclosures shall be supplied with built in Anti Vibration Mountings (AVMs). As such Genset can be installed directly on the leveled surface. Exhaust piping outlet should not be turned towards window / ventilator of home or occupied building. Provision of rain cap should be ensured. The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

Service Accessibility

Genset / Engine control panel should be visible from outside the enclosure. Routine / periodical check on engine / alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure. For major repairs / overhaul, it may be required to dismantle the acoustic enclosure. Sufficient space should be available around the Genset for inspection and service.

General Design Guidelines

To avoid re-circulation of hot air, durable sealing between radiator and canopy is must. Ventilation fans are must for the Gensets cooled by heat-exchanger system. Exhaust piping inside the enclosure must be lagged (except bellow). Temperature rise inside the enclosure should not be more than 5°C for maximum ambient above 40°C and it should be below 10°C for ambient below 40°C. There should be provision for oil, coolant drain and fill. Fuel tank should have provision for cleaning. The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recommended by the engine manufacturer.

Specifications for Acoustic Enclosure

The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for outdoor installation exposed to weather conditions, and to limit overall noise from the enclosure as per CPCB norms under free field conditions. The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall conform to the details as under:

- The enclosure shall be fabricated out the CRCA sheet of thickness not less than 1.6 mm on the outside cover with inside cover having not less than 0.6 mm thick perforated powder coated CRCA sheet.
- The hinged doors shall be made from not less than 16 SWG (1.6 mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.
- All sheet metal parts should be processed through 7-tank process.
- The enclosure should be powder coated.
- The enclosure should accommodate the daily service fuel tank of the D.G. Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running. The gauge should be calibrated. The fuel tank should be filled from the outside as in automobiles and should be with a lockable cap.
- The batteries should be accommodated in the enclosure in battery rack.
- The canopy should be provided with high enclosure temperature safety device.
- The acoustic lining should be made up of high quality insulation material i.e. rockwool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturer's to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated M. S. Sheet duly powder coated / GI sheet/ aluminium sheet.
- The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose. Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance & repairs.
- The canopy should be as compact as possible with good aesthetic look.
- The complete enclosure shall be of modular construction.
- The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G sets.
- The acoustic enclosure should be suitable for connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof conforming to IP-65 protection.
- The inside of enclosure should be provided with at least two nos. 18W LED Batten luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all conditions.

20. ELEVATOR

SCOPE

(i) This specification covers design, supply, installation, commissioning & testing of items required for earthing system including grounding conductors, rods, fittings, accessories of elevators.

(ii) The work shall be carried out in accordance with PWD general specification for electrical work and as per relevant IS codes of practice with regulation of local codes/Bye-laws as per the direction of Engineer-in-charge. The following codes/specifications shall be generally adhered to:

(a) IS 14665 (Part 1) ELECTRIC TRACTION LIFTS - PART 1 : GUIDELINES FOR OUTLINE DIMENSIONS OF PASSENGER, GOODS, SERVICE AND HOSPITAL LIFTS .

(b) IS 14665 (Part 2 / Sec 1 & 2) : ELECTRIC TRACTION LIFTS - PART 2 : CODE OF PRACTICE FOR INSTALLATION, OPERATION AND MAINTENANCE - SECTION 1 : PASSENGER AND GOODS LIFTS - SECTION 2 : SERVICE LIFTS

(c) IS 14665 (Part 3 / Sec 1 & 2) : ELECTRIC TRACTION LIFTS - PART 3 : SAFETY RULES - SECTION 1 : PASSENGER AND GOODS LIFTS - SECTION 2 : SERVICE LIFTS

(d) IS 14665 (Part 4 / Sec 1 & 2) : ELECTRIC TRACTION LIFTS - PART 4 : COMPONENTS - SECTION 1 : LIFTS BUFFERS - SECTION 2 : LIFT GUIDE RAILS AND GUIDE SHOES - SECTION 3 : LIFT CARFRA

(e) IS 14665 (Part 5 / Sec 1 & 2): ELECTRIC TRACTION LIFTS - SPECIFICATION - PART 5 : INSPECTION MANUAL

EXTENT OF WORK

(i) The extent of work covered by this specification is as follows:

(ii) Design, fabrication and supply of lift complete with all devices as are necessary to complete the installation in accordance with this specification.

(iii) Complete wiring of all electrical equipment from the point of supply onwards required for the safe and satisfactory operation of the lift as specified herein. The PURCHASER will provide 415 Volts, 3 Phase, 3 Wire and 240 Volts, Single Phase A.C. supplies or 415V, 3ph, 4 wire supply at one point.

(iv) Installation and commissioning of the lift equipment shall be complete with the accessories and auxiliary equipment.

(v) The structure/lift shaft in which the lift will be installed will be supplied and erected by the PURCHASER. VENDOR shall furnish all the information required by the PURCHASER to enable him to design the structure/lift shaft. VENDOR's supervisor shall supervise the installation of inserts in the lift shaft, and shall be responsible for the correctness of the civil work in this regard.

(vi) With each lift the Vendor shall supply a maintenance tool kit.

(vii) Quantity and Quality of service- Minimum recommended quantity and quality of service shall be as per NBC (Latest version)..

DESIGN FEATURES

(i) The design of the equipment offered should meet the following criteria:-

- Usage of the latest state of the art technology.

- Design enhancements should not reduce the life cycle of equipment / components
- Design life of at least 20 years
- Highest levels of reliability& equipment availability
- Lowest maintenance cost
- Modular design
- Minimum life cycle cost
- High traceability of components through unique bar coding / serial nos / tagging
- Lowest energy consumption
- Highest levels of safety
- Environment friendly
- Code compliance

(ii) The landing doors shall be of the weather proof type when lifts are used in outdoor locations.

(iii) All electrical devices like contactors, push buttons, indicating lamps located outside the machine room shall be housed in dust tight/water tight enclosures as specified in Data Sheet.

(iv) Special care and precautions shall be taken regarding the hanging of lift cable loops between the points of suspension as the loops are prone to twist/distortion. Passenger lifts with travels above 30 metres shall comply with the following additional requirements.

(v) Cable anchorages; both on lift well and car; shall have adjustment facilities for the rotation of each cable to eliminate the accumulated twist without disturbing or disconnecting the cables.

(vi) All the controls and interlocks shall be executed in micro processor based circuits.

(vii) Lifts required to be installed in corrosive areas shall comply with the following additional requirements.

(viii) All electrical devices shall be provided with enclosures specified in the Data Sheet.

(ix) Copper or copper bearing material shall not be used in parts exposed to the atmosphere.

(x) Lift ropes shall be made of stainless steel whenever specified in Data Sheet.

(xi) Lifts required to be installed in hazardous areas shall comply with the following requirements.

(xii) All electrical devices mounted outside the machine room shall be housed in enclosures specified in Data Sheet.

(xiii) Lift shall be provided with emergency lighting & alarm bell in each cab through car mounted dry cell rechargeable battery with minimum 5 years life expectancy & solid state battery charger, necessary changeover relays.

(xiv) Provision of additional weight for interior finishes shall be kept for passenger & capsule lift as specified in the Datasheet. In case interior finishing materials in cab exceeds this provision, then the lift contractor shall clearly identify the loss of carrying capacity, if any. Recess in platform of 20 - 25 mm shall be provided in floor for receiving stone flooring in the passenger lift.

(xv) In addition car lighting will be connected on the emergency lighting UPS system. Location of light fixture to be coordinated with architects \ Interior Designer. Light output shall be minimum 100 LUX at floor level. Fully automatic operation of the lighting & Ventilator fan inside the car shall be provided to put off the lights/ fan in idle condition.

(xvi) For overhead height, pit depth, car size with respect to lift well size, lift entrance size, passenger & load carrying capacity of different types of lifts based on their application, speed criteria, machine dimensions in case of lifts with machine room refer National Building code of India (NBC) – Part 8:Building Services, Section 5:Installation of Lifts & Escalators.

(xvii) For machine room less lifts which include normal & capsule lifts the specification, finishes, dimensions shall be finalised together in consultation with client, architect & lift Vendor.

(xviii) For buildings having height of 15 m or more atleastat least one lift shall meet the requirements of fireman'sliftfireman's lift as given below,

(xix) The fireman's lift shall have the following minimum requirements:

a) Lift car shall have floor area of not less than 1.44 square meters. It shall also have a loading capacity of not less than 544 kg (8 persons).
b) Lift landing doors shall have a minimum of fire resistance of one hour.
c) Doors shall be of automatic operation for car and landing.

Machine Equipment

(i) Hoisting machines shall be gearless type for speed more than 1 m / sec and geared type for speeds of 1 m/sec or lower unless otherwise specified in the technical datasheets.

(ii) Geared hoisting machine shall be single worm geared traction type with AC induction or P.M.S.M. AC VVVF motor, brake, gear, drive shaft, gear case andcase and deflector sheave assembled & compactly mounted on a continuous bed-plate and set on steel beams. Sound isolating pads shall be installed beneath the machine bed-plate to reduce vibration or air borne noise.

(iii) Gearless hoisting machine shall be AC induction or P.M.S.M. ACV3F gearless traction type motor with brake, drive sheave, and deflector sheave assembled & compactly mounted on a continuous bed-plate and set on steel beams. Sound isolating pads shall be installed beneath the machine bed-plate to reduce vibration or air borne noise.

(iv) The motor shall be reversible type particularly designed for lift service with high starting torque and low starting current. Sound reducing material shall be installed under machine.

(v) Hoist machine mounted direct drive shall be provided with digital, closed-loop velocity encoder. Hoist machine drip pans shall be provided to collect lubricant seepage if required. Ladders and platforms with handrails and toe boards shall be provided for overhead sheave access within the bounds of the machine room.

(vi) Requirements for permanent lifting hooks hoisting beams and access hatches shall be indicated on the drawings by the lift system, supplier / installer.

(vii) For Machine Room less Type lifts AC induction or P.M.S.M. ACV3F gearless traction type motor with brake assembly, drive sheave, and deflector sheave mounted in proper alignment on a common, isolated machine support frame shall be provided at the top of the lift or mounted on the back of the guide rail at the top landing. The machine shall be located directly above the lift. Suitable beams shall be furnished for mounting deflector pulleys, if required by the lift contractor. The break-release mechanism shall be operable from the last landing without entering into the lift.

(viii) The motor shall be reversible type particularly designed for lift service with high starting torque and low starting current. Starting current shall not be more than 2.5 times the normal current. All drives shall be rated for not less 150 starts per hour. The processor shall control the drive motor speed through pre-calculated acceleration and deceleration references for achieving smooth rides. The controller should achieve maximum inter floor speeds.

(ix) Sound reducing material shall be installed under machine. Hoist machine mounted direct drive shall be provided with digital, closed-loop velocity encoder.

(x) Ladders and platforms with handrails and toe boards for overhead sheave access within the bounds of the machine room.

Emergency Cracking

(i) The hoisting machines shall be provided with a set of special tools including a hand crank to allow release of hoist brake and provide for manual movement of the car in case of emergency. These tools shall be hung up on a tool board fitted to a wall in the lift machine room, with instructions for their use clearly written on the board both in English and the local language. The lift system supplier shall qualify his bid with respect to manual cranking. An automatic switch shall be provided to interrupt power to the lift mains. Upon withdrawal of crank and manual resetting of power monitor switch, power shall be restored.

(ii) In case of machine room less type lifts, emergency cranking shall be a part of lift control panel.

Speed Governor

(i) The car safety shall be operated by a mechanical centrifugal type car & counterweight driven speed governor located in the upper part of the lift well for both lifts with or without machine room. The governor shall actuate a switch when excessive descending speed occurs, disconnecting power to the hoist motor and applying the brake prior to deployment of the safety.

Power Conversion and Regulation Units for direct-current power for the operation of hoist machine brake, door operator, dispatch processor, signal fixtures, etc.,\ solid-state, alternating current, variable voltage \ variable frequency (ACV3F), I.G.B.T converter/inverter drives \ controllers. Units shall be design to limit current, suppress noise, and prevent transient voltage feedback into building power supply, Suppress solid-state converter noises, radio frequency interference, and eliminate regenerative transients induced into the mainline feeders or the building standby power generator

Direct drive, solid-state, digital type encoder shall be provider to update car position at each floor and automatically restore the same after power loss.

Note - All lift equipment including their supports and fastenings to building, shall be from the building structure minimize objectionable noise and vibration transmission to car, building structure, or adjacent occupied areas of building. Noise level relating to lift equipment operation shall not exceed 60 dBA.@ 1 mtr.

Lift Materials:-

(i) Lift materials shall be non-flammable except traveling cable which shall be flame resistant. All other electrical cables shall also be flame resistant and housed in metal conduit or other metal enclosures.

(ii) Guide Rails:-Steel guide rails shall be installed to guide theguide the car and counterweight, erected plumb and securely fastened to the building structure, fitted to ensure smooth joints. The guide rail shall be minimum 16 mm, tongued and grooved type.

(iii) Buffers:-Oil or spring type buffers shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 or local code if more stringent. Clearance from underside of car resting on a fully compressed buffer shall be not less than 1.20m. Buffer shall be designed for design speed + 15%. The oil buffers shall be self resetting type and shall be provided with means for determining the oil level. Switch shall be provided on buffer to limit car speed if buffer is compressed Ladder(s) and platform(s). It shall be provided buffer access.

(iv) Oil buffers shall be provided for the passenger lifts for speed of more than 1.5 mps and for Machine room less lifts for all speeds. The normal operation of the lift shall depend on the return of the buffers to their normal extended position after operation. The device for checking this shall be an electric safety device mounted on the buffers.

(v) Car:-A car-frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral with car-frame or shall be mounted on the bottom members of the car-frame, and shall be of the flexible guide clamp type designed to stop and hold a fully loaded car which exceeds descending speed. Safety shall conform to ANSI/ASME/CENEN-81 or local codes if more stringent. The car platform shall be of Aluminium/ Stainless steel plate as asked for in the BOQ. The entire platform shall rest on rubber pads, so that it will designed to form an isolating cushion between the car and car frame. Platform deflection shall be limited to maximum 3 mm under maximum normal operating conditions. In case of service lifts, the platform shall be provided with slip resistant Aluminium/Stainless Steel chequered plate flooring. The platform shall be arranged to accommodate one piece load of mechanical / electrical equipment, etc. For servicing the car mechanical hatch to be provided as per design of lift manufacturer.

(vi) Car Top Station:- A car top operating station shall comprise of key operated switch and constant pressure up/down buttons which shall be provided on each lift. Car shall respond to up/down command at inspection speed. The lift contractor shall provide light fixture of 36 watt enclosed fluorescent or enclosed 2 x 18 Watt compact fluorescent switched from car top station.

(vii) Counterweight:-A structural steel frame with cast iron or steel plate filler weights shall be furnished to provide proper counterbalance for smooth operation.

(viii) Counterweight:-A metal counterweight guard shall be furnished and installed at the bottom of the lift, and shall wrap around counterweight rails for a height of no less than 1.80 m in order to protect accidental contact.

(ix) Sheaves:-Sheaves shall be machined grooves, balanced and shall maintain cable /sheave ratio well within requirements. Lubrication points shall be extended to a location that is easily accessible. No deflector sheaves to protrude into lift.

(x) Lift & Governer Ropes:-Lift ropes shall be traction steel of size, construction and number to insure proper operation of the lift and give satisfactory and safety

assurance. Governor ropes shall be steel or to suit manufacturer's specifications. All ropes shall consist of at least eight strands wound about a hemp core center. All ropes shall conform to ANSI/ASME/EN-81 or more governing codes or regulations. The minimum factor of safety for ropes shall be 10.

(xi) Compensating Rope:-Compensating ropes shall be furnished and installed for all lifts with speed over 2.0 m/sec, and travel in excess of 30 m, to compensate for the shifting weight of the hoist ropes. A device shall be provided to tie the car and counterweight together to limit the jump of the car or counterweight. Compensating chain where provided shall be enclosed in a plastic flame resistant jacket to minimize noise.

(xii) Lift Operating Devices:-Redundant series wired terminal stopping devices shall be provided to slow down and stop the car automatically at the terminal landings. Resetting a tripped device shall be done manually only.

(xiii) Pit Switch:-An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of position in the lift.

(xiv) Travelling Cables:-Travelling cable shall be secured to the cars underside. Cable shall be clear of all obstructions while car is in motion. Rubbing or chafing of cables against hoist-way or equipment within hoist-way to be avoided. Lighting & power cable shall be with Fire retardant outer sheath. Shielded wires and cables shall be provided for music, car access control, phone, TV, etc. Twisted type, 4 pair 14/0076 music cables and 4 pair 0.5 dia. Cat 3 cable for communication system shall be used. Travelling cables shall be flexible and suspended to relieve strain on individual conductors. A minimum of 10% spare conductors shall be provided in travelling cable.

(xv) Wiring:-All wiring and electrical interconnections shall comply with governing codes. Wiring shall 1100 volt grade LSZH type and shall run in metal conduit, tubing or approved electrical raceways

Lift entrances & Car doors

(i) All landing lift entrance door shall have center opening horizontal sliding type doors unless otherwise specified suitable for a clear opening as indicated in Technical Data for each type of lift and shall include flush doors of hollow metal construction, extruded aluminium sill with anti slip grooving and hanger supports and hanger cover shall be provided. Exposed surfaces of doors and frames shall be finished as directed by the Interior Designer.

(ii) Sheave type two point suspension ball bearing door hangers and tracks shall be furnished for each lift opening. Sheaves shall not be less than 58 mm diameter and adjustable ball bearing rollers shall take the up thrust of the doors.

(iii) Lift Entrances to have minimum two hour fire protection. Complete entrances bearing fire labels from a nationally recognized testing laboratory approved within the governing jurisdiction.

(iv) Car doors shall, unless specifically stated, be center parting, automatic power operated, variable frequency door operator or PWM DC door operator and electronic door detector. Infrared light beams covering full height & width of entrance shall be provided to act as a safety curtain across the door entrance to monitor the door closing.

(v) Car doors shall be hung plumb and even, to within 1 mm. with minimum number of 4 gibbs per leaf. Floor gibbs shall be well fitted so as to prevent popping noise

as a car passes structural members, or car in motion in a shared shaft, etc. Lift doors shall be hung plumb and show a maximum of 6 mm joint at sides, top and bottom and 2 mm at centre joint. Narrow door frame or jamb panel shall be supplied by lift contractor. A soft chime shall ring prior to doors closing and opening.

(vi) In normal condition, Car cannot move when the car or hoist-way door is open. During emergencies, car and hoist-way doors shall be capable of being opened from outside.

(vii) Frames: 14 gauge hollow metal at all floors. Door Panels: 16 gauge steel, sandwich construction without binder angles. Leading edges of center-opening doors shall be provided with rubber astragals. Each car & lift door leaf shall be fitted with minimum of two (2) gibbs per panel, one at leading and one at trailing edge with gibbs in the sill groove entire length of door travel. Sight Guards: 14 gauge, same material and finish as lift entrance door panels. Construct without sharp edges.

(viii) Sills: Extruded aluminium.

(ix) Sill Supports: Structural or formed steel shall be designed to support door sill based upon car loading classification.

(x) Struts and Headers: Vertical support shall be provided of entrances and related material with door open bumpers on entrances equipped with vertical struts.

(xi) Upon the car reaching landing in response to a hall or car call, a soft chime in the car shall sound. Door opening shall commence when the car is 25 mm from the leveling. Door open period shall be adjustable to within a range of + 1 second. Door-open-period on all floors except lobby floor shall be shortened to the extent that door closure will commence 2 seconds (field adjustable) following the sensor beam interruption by the last boarding or disembarking passenger. This period shall be adjustable to 1.5 seconds ± 1.0 seconds. Normal door-open-period at lobby floor shall be monitored by the car's CPU. Door closure shall override "door-open-period" where car loading has reached by pass limit, or when another car approaches the lobby floor.

(xii) An approved positive interlock shall be provided for each lift entrance which shall prevent operation of the lift unless all doors for that lift are secured and shall maintain the doors in their closed position while the lift is away from the landing. Emergency access to theto the hoist-way as required by governing codes shall be provided.

(xiii) Car And Hoist-Way Door Operator: For each lift door, an electric VVVF door operator or PWM DC door operator shall be furnished to simultaneously open the car and hoist-way doors when the car is at a landing. The doors shall be closed simultaneously by motor power. Emergency key provision shall be made to open doors at all landing from outside of the hoist-way. In the event of interruption of electric power or failure of the door operator, it shall not be possible to open the car door manually from within the car. An electric contact for the car door shall be provided which shall prevent lift movement away from the landing unless the door is in the closed position. Each hoist-way door shall be equipped with a positive electromechanical interlock and auxiliary door closing device so that the lift can be operated only after the interlock circuit is established. The doors shall open automatically while the car is leveling at the respective landing. The doors shall automatically close after a predetermined time interval has elapsed, but the momentary pressure of the "door open" button provided in the car shall reverse the

motion and reopen the doors and reset the time interval unless overridden by the electronic door monitor.

(xiv) Door operation shall be consistent, smooth and quiet at all floors, regardless of door weight or varying air pressure.

(xv) Door Control Device:- Photoelectric door monitors shall be installed on each lift with full screen infrared matrix or multiple beams extending vertically along leading edge of each door panel to full height of door above finished floor. This device shall prevent doors from closing and reverse doors at normal opening speed if beams are obstructed while doors are closing, except during nudging operation. In event of device failure, provide for automatic shutdown of car at floor level with doors open. After beams of door control device are obstructed for a predetermined time interval (minimum 20.0 - 25.0 seconds), warning signal shall sound and doors shall attempt to close with a maximum of 1 kgm kinetic energy. Activation of the door open button shall override nudging operation and reopen doors. When beams are interrupted during initial door opening door shall be remain open for minimum of 3.0 seconds. When beams are interrupted after the initial 3.0 second hold open time, hold time will reduce to 1.0 -1.5 seconds and which is adjustable.

All lifts shall be equipped with automatic lift retrieval system which shall, upon signal from the central fire alarm system or manually operated key switch, cause all lifts to be dispatched automatically to the ground floor. Lifts shall, open their doors and remain at the ground floor. All floor and car buttons shall be rendered ineffective until the system is manually reset. A smoke detector shall be placed in close proximity to each lift bank on the ground floor. If this device senses smoke, system shall land lifts at a preselected, alternate, landing floor. A key operated switch shall be provided at the ground floor to activate and reset the retrieval system manually.

(xvi) Emergency operation shall return the lift/s to a designated floor, most commonly, the Lobby, by means of a signal from the automatic fire alarm system.

(xvii) On initiation from the fire alarm system, control panel, all lifts travelling away from the lobby floors shall stop and reverse without opening their doors indicating fire mode-operation to passengers, ignoring all car and hall calls and express to the lobby or assigned floor.

(xviii) Cars travelling toward ground shall express to ground ignoring all car and hall calls. Cars parked on intermediate floors shall close their doors and express to ground. Cars parked at lobby shall open their doors ignoring car and hall calls. All hall and car buttons shall extinguish and shall accept no further hall or car registration.

(xix) All lifts shall, in addition and where allowed by code, be provided with a key operated switch for use by in-house fire brigade.

(xx) The lift contractor shall coordinate and cooperate with the fire detection & alarm system supplier / installer for his system interfacing responsibilities.

Fireman Emergency

(i) Actuation of fire mode shall put all car functions as described here under fireman control by means of a key switch.

(ii) Hall button giving car call indication shall cause the doors to close.

(iii) Applying constant pressure to the door open button shall cause door to begin to open. Releasing the button before door is fully open shall cause the door to close.

(iv) Hall buttons shall be rendered inoperative.

(v) Car position indicator shall indicate floor when car is within door operating range, and if in motion it shall indicate nearest floor by flashing. When a car is within operating zone, the position indicator shall light uninterrupted.
(vi) All electrical door safety locks shall remain effective.
(vii) Car position, direction of travel and floor conditions shall be displayed on the car position monitor in the lobby, and at lift system monitor in engineering room.
(viii) Returning the car to the designated landing floor, deactivating the lobby switch shall render the car to original pre fire mode condition.
(ix) Resetting the Fire Alarm contacts in the car monitoring panel shall restore the system to normal condition.

Aswitch shall be provided in the car to permit operation of the lift from top of the car for inspection purposes, with car and hall buttons inoperative. Car shall travel at inspection speed not exceeding 0.5 m/sec. Motion of car shall require constant pressure to directional button.

A key operated switch shall be provided in the car operating station which, when actuated, shall disconnect the lift from the hall buttons and permit operation from the car buttons only.

Lift control panel (ECP) shall be vertical, totally enclosed cubicle constructed of sheet steel with hinged doors on the front and screwed panels or hinged doors on the back, giving easy access to all components inside the controller. The cubicle enclosure shall be minimum of IP 22. Panel Ventilatingventilating fans shall be provided to maintain components temperature within limits.

It will have a microprocessor with solid state switching devices sequenced and interlocked It will have monitoring points for Lift position & Emergency Stop ECP should be located such that it can be easily accessed from the last landing and shall be key locked and vandal proof.

It will provide protection but not restricted to the following:

(i) No-voltage or sustained under voltage
(ii) Overcurrent in any component
(iii) Phase reversal of the power supply
(iv) Overload
(v) Single phasing

ECP shall be arranged to cut-off the power supply, apply the brake and bring the car to rest at the nearest landing in the event any of the above failures occur. Same should happen, in the event of a signal from the Fire Alarm Control Panel.

Transducers in the car platform shall monitor passenger load which shall override “pre-programmed door open period” and dispatch the loaded car from the low terminal. The load weighing device shall also function in the same manner on all intermediate and top floors and in addition shall express to the next car call and ignore all hall calls. Hall calls which are bypassed shall not be canceled. The automatic load bypass device shall be field adjusted for 50% - 75% of rated load.

Any modification in the civil works required shall be clearly brought out by the bidder. No extra claims will be entertained on this account at a later date..

The lift control system shall have a Fire Alarm signal accept facility, if specified in Data sheet. The 'lift recall' function shall be activated in the receipt of such a signal & lift car shall halt on the specified floor with their doors opened.

The lift control system shall have a RS 232 / RS 485 interface, if specified in Data sheet for connecting to the Building Automation System. Adequate number of NO / NC contacts need to be provided in the lift control system for indicating the position of lift car in a remote location.

Push to talk facility-

(i) Each lift shall be fitted with an intercom system to allow at least 3-way, hands free, conversation between the lift car, machine room & two remote stations.
(ii) The microphone & speaker unit shall be concealed behind the COP in the lift car & is activated by pressing the button which has an indication glowing when intercom is in operation. The master unit in the remote stations has to have an indicator for each lift.

Provision for Handicapped Persons:

(i) Lift control buttons & Hall call buttons shall be provided at locations and height specified in IS 15330 – 2003.
(ii) Braille notations indicating the floor levels shall be incorporated next to each button at the Car operating panel (COP) and hall call buttons.
(iii) Handrail-At least on one side wall of the car a handrail shall be installed. The gripping of this handrail shall have a minimum circumscribed diameter of 30 mm and a maximum of 45 mm. The free space between the wall and the gripping part shall be at least 45 mm. The height of the top edge of the gripping part shall be within 900 mm+ 0/–25 mm from the finished car floor level. The handrail may be interrupted where the car operating panel is located in order to avoid obstructing buttons or controls.
(iv) Mirror- where a passenger in a wheelchair is unable to turn around, a device to observe obstacles when moving backwards out of the car shall be installed, for example a mirror installed in an appropriate position. Where glass is used as mirror it shall be of a laminated safety glass. The lowest part of the mirror should be a minimum of 300 mm from the floor.
(v) VOICE SYNTHESIZER (Digital type): A digital voice system for announcing the car position, opening/closing of doors, direction of travel and messages shall be provided as per IS: 15330 – 2003.
(vi) Following messages in at least two languages per Client requirement to be provided;
    - Arrival at the floor & its designation.
    - Lift failed to start, please press the door open button
    - ARD operation

The Elevator Panel should have the following Provisions

(i) It shall be able to accept signal from the Fire Alarm Panel in case of fire and automatically ground the elevator on receipt of this signal.
(ii) Potential free contact to indicate elevator trip status.
(iii) Potential free contact to indicate elevator alarm status.
(iv) Potential free contact to indicate Emergency Activation Switch status.

FAS contractor shall provide necessary cabling up to Elevator Panel and termination shall be done by Elevator contractor.

For integration with PA System, additional cabling to be provided from lift car to the Lift machine

Software Interface.

The Lift microprocessor panel should be compatible with BAS and should be able to communicate with the BAS in any of the following standard protocol like MODBUS, LANWORKS, BACNET etc. In case of multiple lifts having individual microprocessor panels it should be possible to network all microprocessors panels and be connected to a master controller. BAS communication cable can be integrated directly to the master controller or in case master controller is not available it should be possible to integrate each Microprocessor controller to the BAS system. It should be possible to monitor the following data points through software integration.

1) Elevator car position.
2) Fire Emergency signal monitoring.
3) Elevator Attendant Mode.
4) Elevator Alarm Mode.

In case of fire it should be possible to control the lift through software interface. All necessary hardware including interface card and accessories necessary for integration with the BAS system has to be provided by BAS contractor.

TESTS ON COMPLETION

The following tests shall be carried out to the satisfaction of the EPI/CDRI.

(i) Insulation resistance and earth test for all electrical apparatus.
(ii) Continuous operation of the lift under full load conditions and simulated starts and stops (150 nos. per hour each) for one hour at the end of which time the service temperature of the motor and the operating coils shall be tested. This shall be as per B.I.S. specification.
(iii) The car shall be loaded until the weight on the rope is twice the combined weight of the car and the specified load. The load must be carried on for about 30 minutes, without any sign of weakness, temporary set or permanent elongation of the suspension rope strands.
(iv) The following items shall be tested:
    i. Levelling accuracy at each landing in conditions of fully loaded and empty car.
    ii. No load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
    iii. Full load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
    iv. One and quarter load current and voltage readings both on ‘Up and ‘Down’ Circuits.
    v. Stalling current and voltage and time taken to operate overload.
    vi. Overload protection.
    vii. Gate sequence relays, if provided and installed.
    viii. Car and landing door interlocks.
    ix. Collective control and priority sequences, if installed.
    x. Safety gear mechanism for car and counterweight with fully loaded car and also with only 68 kg load.

xi. Speeds on Up and Down travel with full load, half load and empty car.
xii. Door contacts.
xiii. Final terminal stopping device.
xiv. Normal terminal stopping device.
xv. Car and counterweight buffers with contract load and contract speed.
xvi. Operation of controllers.
xvii. Manual operation of lift at mid-way travel.
xviii. Emergency operation.

(v) Tests on completion shall also be performed to the satisfaction of Inspector of Lifts and a certificate will be obtained from the 'Lift Inspector 'by the contractor.

(vi) The test certificates for the following would be required before handover: -

i. Hoist ropes
ii. Governor ropes
iii. Over speed governor
iv. Buffers
v. Main motor & Door drive motor
vi. Safety gear
vii. Fire rating for doors
viii. Controller

SAFETY ITEMS

Following safety items shall be provided in each machine room / Lift;

i. First Aid Box
ii. Co2 / foam based fire hydrant cylinders
iii. Danger Plates
iv. Rubber mats in front of each controller
v. Electric shock treatment charts
vi. Any other safety item that may be required by authorities.

Contractor to cover the cost of these items in his quoted rates, nothing extra shall be paid on this account.

TECHNICAL DATA SHEET

S.N.	DESCRIPTION	DETAILS
1	TYPE OF ELEVATOR	Passenger Elevators Machine Room less
2	QUANTITY	As per Architectural Drawings / Traffic Analysis
3	CONTROL	VVVF
4	OPERATION W/WO ATTENDANT	Duplex, Full Collective

S.N.	DESCRIPTION	DETAILS
5	CAPACITY	
a.	Weight in Kgs.	As per requirement
b.	Weight for interior material of the car	Bidder to Decide
c.	No. of persons	Bidder to Decide
6	MACHINE	Bidder to Indicate
7	SPEED (MPS) rated	AS per NBC 2016
8	TRAVEL	As per requirement
9	RISE IN METERS	As per requirement
10	STOPS AND OPENINGS	As per requirement
a.	No. of Stops	As per requirement
b.	No. of openings	All openings on same side.
11	CAR SIZE IN (MM) (Inside Dimensions)	As per NBC
12	AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions)	As per architecture drawing

S.N.	DESCRIPTION	DETAILS
13	CAR AND HOISTWAY ENTRANCE (MM)	1000, 2 C
14	DOOR OPERATION	Automatic with electronic door detector
15	INTERIOR (CAR ENCLOSURE) With SS hand rail	Walls – Stainless steel in dot matrix (Scratch less) Floor – 19mm thick granite stone. Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan

The Contractor shall also carryout all tests/ operations as required by the inspector or local authority to obtain the approval of elevator installation and operation of elevator plant and to submit the same to the owner/employer. All such test, follow up action and liaison with inspector or local authority shall be deemed to be included in the prices quoted by the contractor and no extra payment on these account will be made to the Contractor. This liaison work shall be deemed to be the part of the contract.

Provision of single phase 50 Hz. AC power supply terminated with suitable sized single phase and neutral switch MCB for i) Lighting in machine room, lift wells, lift pits. ii) Lighting outlet points in the lift shaft.

Properly ventilated machine room, lift shafts and water proofed lift pits. However, if due to any reason whatsoever any water proofing is required, the same is to be done by the contractor at his own cost and nothing extra shall be paid on this account.

21. UNINTERRUPTED POWER SUPPLY (UPS) – MODULAR TYPE

SCOPE

This specification covers the requirements of Modular Type Uninterruptible Power Supply System (UPS) to critical AC load systems, which have stringent requirements, imposed on voltage and frequency regulation, harmonic content, transient recovery and expansions in phased manner.

APPLICABLE CODES AND STANDARDS

The design, manufacture, performance testing and inspection of equipment shall comply with all currently applicable statutory regulations and safety codes in the locality, where the equipment will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

SYSTEM REQUIREMENTS

The UPS system shall be true online static type and the components of UPS shall isolate power line transients, frequency and voltage variations. The UPS shall provide no-break power supply to the critical loads under normal conditions, during outages in the input power and during failure / mal operation of the main components of the UPS by switching to the alternate supply.

The UPS system shall be modular in design allowing for ease of maintainability. The individual modules shall be constructed to allow for the removal of components without removing other modules or the use of special tools.

The UPS system shall operate in an “N+n” configuration where “N” is the number of UPS modules/ units connected in parallel to support the full rated load and “n” is the number of UPS modules/ units connected in parallel to provide the redundancy in case of failure of UPS modules/ units.

In the event of failure of one UPS module/ unit, that particular UPS module/ unit to be automatically isolated from the system and the remaining UPS module/ units shall continue to support the full load.

Replacement or repair of a UPS module/ unit shall be achieved without disturbance to the connected load.

Servo Controlled Voltage Stabiliser (SCVS) shall be provided for bypass.

A manually operated make before break changeover switch/ MCCB shall be provided to completely bypass the UPS power circuits (inverters and static switches) for maintenance and repair purposes.

DESIGN REQUIREMENTS

All UPS components, i.e. rectifier, inverter, static switch, by-pass switch and associated controls shall be mounted in floor mounted, sheet steel panel. The panels shall be designed for continuous operation for the ambient conditions.

UPS Modular Technology should have parallel architecture. Each UPS module shall have its own operating panel, display panel, its own CPU and a power module.

UPS MODULE

The UPS modules shall be of double conversion, continuous duty (true on- line), and scalable, plug-in and hot swappable technology, accommodated in the UPS system rack / cabinet. Each UPS module shall consist of a rectifier, inverter and its controller. If one UPS module fails, the UPS system shall have the capability to replace the faulty UPS module online.

BATTERY

The battery backup time, number and type of batteries shall be as specified in Data Sheet-A1. The BIDDER shall choose the required voltage of the battery. The AH capacity of battery shall be chosen by BIDDER, based on the battery backup time/ duty cycle, and minimum ambient temperature specified in Data Sheet and the guaranteed DC/ AC efficiency of the UPS system offered.

BIDDER shall furnish calculation for sizing of the battery based on the requirements specified in Data Sheet.

UPS shall have Modular battery, i.e., Batteries shall be modular mounted in UPS cabinet.

RECTIFIER

The rectifier shall essentially be IGBT type. The rectifier shall be provided with soft start feature. The rectifier shall have features for temperature compensation charging of the batteries.

The rectifier shall be capable of supplying the inverter full load, in addition to charging the fully discharged batteries in 8 to 10 hours or as recommended by battery manufacturer and then maintain the battery on trickle charge mode.

INVERTERS

The inverter shall be of IGBT type. The inverter system shall be complete with necessary filters to limit the harmonic distortions to the load. The system shall have features to prevent deep discharge of battery. The inverter shall be self- protecting against any magnitude of connected output overload.

STATIC SWITCH

The current rating of the static switch shall be not less than the continuous full load rating of the branch circuit

Automatic initiation of the transfer from a faulty branch circuit to either a healthy branch circuit or the stand-by regulated source shall be accomplished during following conditions:

(a) Inverter/ rectifier failure.

(b) Loss of inverter AC input.

(c) Load over current (in case of non-redundant UPS with static by pass to regulated supply).

UPS systems shall have one of the two types of static transfer system described below:

(a) Separate static bypass for each module (Multiple Path Static switch): The load is to be transferred automatically to the bypass line via each of the UPS module with their static bypass switches being triggered simultaneously.

(b) Centralized Static Bypass: The load is to be transferred automatically to the bypass line via Centralized static bypass

REGULATED STAND-BY AC SUPPLY

Regulated stand-by AC supply shall be derived from stand-by source through a 3 ph servo controlled voltage stabiliser (SCVS) and a 3 phase/3phase-1phase Delta-Vee connected adequately rated isolation transformer as specified in Data Sheet-A1.

CIRCUIT PROTECTION

The following devices shall be provided to protect the UPS system:

(a) AC input circuit breaker to Rectifier unit

(b) AC input circuit breaker to stand-by transformer/ voltage stabiliser

(c) DC circuit breaker for battery output

(d) Fast acting semiconductor fuses

INDICATIONS & ANNUNCIATION

The UPS system shall be provided with necessary meters, mimic diagram, local indication / alarm conditions.

Multi line alpha numeric text display unit shall be provided for continuous monitoring of the UPS operation. The UPS control system shall be fully compatible for remote operation via communication link. BIDDER to indicate the type of communication protocol supported by the system along with the details of links provided in the system. The control system shall operate on Windows or eqvt. platform. The following operating conditions shall be annunciated:

Alarm Indication:

(a) System fault

(b) Rectifier charger failure

(c) Inverter failure/ faulty

(d) Battery under voltage

(e) UPS over temperature

(f) Over load

(g) Static transfer to stand-by

(h) Transfer inhibited

(i) Over load shutdown

(j) Emergency shutdown

(k) Battery circuit breaker / switch open

(l) AC Mains failure

(m) AC stand-by source mains failure

(n) Manual bypass ON

(o) Fan failure

(p) Asynchronous condition

(q) Control power failure

Status Indication on Mimic:

(a) Mains on

(b) Rectifier on

(c) Battery on load

(d) Inverter on

(e) AC Stand-by source on

(f) Inverter on – load

(g) Manual by-pass on

(h) Load on static by pass.

Display of measurements:

(a) Inverter output phase-to-phase voltages

(b) Inverter output currents

(c) Inverter output frequency

(d) Voltage across battery terminals

(e) Rectifier input phase-to-phase voltages

(f) Rectifier input currents

(g) Crest factor

(h) Active and apparent power

(i) DC voltage & Current

HARMONICS

Necessary input and output filters shall be provided or the Rectifier and Inverter design shall be such that the harmonics injected back to the source and to the load shall be within limits specified in IEEE standards at the point of coupling of the UPS to the system. The fault level of the system at the point of common coupling shall be as specified in Data Sheet-A1.

AC DISTRIBUTION BOARD (ACDB)

ACDB shall be supplied along with the UPS.

SYSTEM EARTHING

The VENDOR shall clearly bring out the earthing philosophy to be adopted for the UPS electronics, protective earthing (PE) and neutral earthing. The requirement of separate earth independent of the plant electrical system earth shall be clearly brought out.

TESTS

Type and routine tests certificates for all components used in the UPS system shall be furnished. Tests for components shall be as per relevant standard specifications.

BIDDER shall furnish his quality assurance plan for the equipment offered. The quality assurance plan shall include bought out components and assemblies used in the UPS system.

Routine tests on the complete UPS system shall be carried out as per relevant standards for each major sub-system in the UPS, viz., Rectifier, Inverters, batteries, stand-by supply, etc.

System tests shall be performed on the completely assembled UPS system. System tests shall include frequency regulations, Voltage regulation, current limiting feature and harmonic content tests in addition to the tests to prove the functional requirements such as synchronisation with range of adjustments, transfer of static switches for conditions of loss of square wave, overload and under voltage conditions.

Type, routine and optional tests covered under clause 6 of IEC-62040-3 shall be conducted on the UPS system in addition to the system tests.

Endurance test on static switches shall be performed for not less than 10 transfer / retransfer cycles at full load.

Heat run test shall be carried out on each branch of UPS including bypass (if provided) and on overall UPS system at rated load under relevant ambient conditions for a period of 8 hours. This test shall be conducted as a routine test on all UPS being supplied.

DRAWINGS AND DATA

All Drawings, data, technical particulars, detailed literature, catalogues, type test certificates etc shall be submitted along with the bid/ after award of contract as specified in Bid Document.

SL. NO.	ITEM	UNIT	
1.1	Application		For supply to critical loads such as desktops, servers, printers, etc and emergency lighting loads
1.2	Power rating at load PF 0.8 lagging		Bidder to calculate
1.3	Quantity (nos.)		
1.4	Method of energy storage		Battery back -up
1.5	Type		Non-Redundant with static by pass to regulated supply
1.6	Parallel Redundant configuration		N+1

SL. NO.	ITEM	UNIT	
1.7	Installation		Indoor , Normal Ventilation
1.8	Ambient Temperature (^{0}C)		50
1.9	Relative Humidity		Upto 95% Non-Condensing
2.0	**ENCLOSURE**		
2.1	Sheet steel thickness		2mm, CRCA for doors and 1.6mm CRCA for side covers
2.2	Degree of protection as per IS-13947		IP42 if located in Non-air conditioned area /IP20 if located in air-conditioned area.
2.3	Painting		
	Exterior		
	- Interior		
2.4	Cable Entry		Bottom / Top
2.5	Acoustic Noise level Measured at a distance of 1m		60 – 65 dBA upto 120KVA 65 – 75dBA above 120KVA
2.6	Space heater, 240V, 1 Ph		Required
3.0	**UPS SYSTEM**		
3.1	Input		
3.1.1	Supply voltage		415 V, 3 PH, 3 W/4W, 50 Hz AC, Non-Effectively earthed / effectively earthed.
3.1.2	Allowable Variation		
	(a) Voltage		± 10%
	(b) Frequency		± 5%
	(c) Combined voltage + frequency		10%
3.1.3	Harmonic content (Input)		<5%
3.2	Output		
3.2.1	Output voltage		110V,1 PH/ 240 V, 1 PH/ 415 V, 3 PH, 4 W

SL. NO.	ITEM	UNIT	
3.2.2	AC voltage accuracy (steady state) over entire load, load PF & DC voltage range.		$\pm$ 2% for balanced load
3.2.3	Transient voltage regulation		8% at 100% load step
3.2.4	Transient recovery		Return to steady state condition within 50 ms after disturbance.
3.2.5	Voltage wave from		Sinusoidal
3.2.6	Range of adjustment of AC output voltage		$\pm$ 5% at rated load
3.2.7	AC Harmonic content(THD-Voltage)		As per IEEE 519
3.2.8	Phase displacement for three phase output		$120^0 \pm 1^0$ for balance load $120^0 \pm 3^0$ for 20% unbalanced load.
3.2.9	Nominal frequency		50 Hz
3.2.10	Frequency regulation (Without static by-pass source)		$\pm$ 0.1 %
3.2.11	Frequency regulation (With static by-pass source)		$\pm$ 2 Hz
3.3	AC standby supply		
3.3.1	Servo controlled voltage stabilizer (SCVS)		Required
	(a) Rating		To match UPS continuous rating
	(b) Overload capacity		10 times rated current for 100ms
	(c) Input voltage phase & frequency		415V $\pm$ 10% 3 ph 3/4 wire 50 HZ
	(d) Percentage voltage regulation		+ 2%
	(e) Spike busters / surge suppressors and input filters		Required
3.4	Maintenance by pass switch		Not Required
4.0	**BATTERY**		
4.1	No. of 100% capacity batteries		
4.2	Type of battery cell		SMF VRLA
4.3	Battery backup time		

SL. NO.	ITEM	UNIT	
4.4	**1.12 MOUNTING ARRANGEMENT**		Open Type Rack : Single tier
5.0	**RECTIFIER**		
5.1	Recharge time on battery boost charge		As per Battery manufacturers recommendation
6.0	**INVERTER**		
6.1	Overload Capacity		125% for 10 Min.
			150% for 1min
			300% for 4 milli seconds
6.2	Synchronising		
	- Between inverters		Not Required
	- Between inverters and standby supply		Required
6.3	Synchronising Range		50 $\pm$ 3 Hz(adjustable)
7.0	**STATIC SWITCH**		
7.1	Maximum transfer time		<5ms
7.2	Short time current rating		1000% for 10 milli seconds
8.0	**CIRCUIT BREAKER & LOAD BREAK SWITCHES**		
8.1	Type		MCCB
9.0	**AC DISTRIBUTION BOARD**		Required
9.1	Type		Integral
9.2	Construction		Single front
9.3	Busbars		Aluminium
9.4	Incoming		MCCB
9.5	Outgoing		MCCB
9.6	Cable entry facility		Bottom
1.	UPS		IEC - 62040 (Part-III)

SL. NO.	ITEM	UNIT	
2.	Basic climatic & mechanical durability tests for components for electronic and electrical equipment		IS 9000
3.	Transformer and inductors (Power, Audio, Pulse & switching) for electronic equipment		IS 6297
4.	Environmental requirements for semiconductor devices and integrated circuits		IS 6553
5.	Terminals for electronic equipment		IS 4007
6.	Degree of protection		IS 13947/IEC60 947-1
7.	Semiconductor converters		IEC 60146
8.	Semiconductor rectifier equipment code		IS 6619
9.	Thyristor converters		IS 5082
10.	Emergency std by power systems		IEEE 446
11.	Harmonic levels		IEEE-519
	Spare List		
1.	MCB/MCCB of each rating		
2.	Semiconductor fuses of each rating		
3.	Control cards		
5.	Thyristors / Power Transistors of each rating		
6.	Power diodes of each rating		
7.	Auxiliary relays & Power contactors of each type.		
8.	Filter capacitors		
9.	Filter choke		

22. UNINTERRUPTED POWER SUPPLY (UPS) – CONVENTIONAL TYPE

The specification covers the requirements of Uninterrupted Power Supply (UPS) to emergency loads, critical AC load systems, which have stringent requirements, imposed on voltage and frequency regulation, harmonic content and transient recovery.

22.1 Applicable Codes and Standards

The design, material, construction, manufacture, performance, inspection and testing of UPS shall comply with all latest versions of standards, statutes, regulations and safety codes in the locality where the equipment is proposed to be installed. Nothing in this Specification shall be construed to relieve the VENDOR of this responsibility.

Sr. No.	Description	Code / Standard
1.	UPS	IEC - 62040 (Part-III)
2.	Basic climatic & mechanical durability tests for components for electronic and electrical equipment	IS 9000
3.	Transformer and inductors (Power, Audio, Pulse & switching) for electronic equipment	IS 6297
4.	Environmental requirements for semiconductor devices and integrated circuits	IS 6553
5.	Terminals for electronic equipment	IS 4007
6.	Degree of protection	IS 13947/IEC 60947-1
7.	Semiconductor converters	IEC 60146
8.	Semiconductor rectifier equipment code	IS 6619
9.	Thyristor converters	IS 5082
10.	Emergency std by power systems	IEEE 446
11.	Harmonic levels	IEEE-519

All codes and standards referred to in the specification shall be understood to be the latest version on the date of offer made by the bidder unless otherwise indicated.

22.2 System Requirements

The UPS system shall be true on line static type and the components of UPS shall isolate power line transients, frequency and voltage variations. The UPS shall provide no-break power supply to the emergency and critical loads under normal conditions, during outages in the input power and during failure / mal operation of the main components of the UPS by switching the alternate supply.

Static UPS systems shall be parallel redundant (N+1) configuration. In this configuration, one number of UPS unit shall be provided as standby. At any point of time one UPS shall act as standby to other main UPS units. Under normal operating condition, all UPS, i.e., N+1 shall be operating in parallel with partial loading. On an event of failure of any one UPS, the remaining UPS will automatically increase the loading and take care of the failed UPS loads. Bidders shall supply all required paralleling accessories along with the UPS. Requirement and configuration of bypass shall be as indicated in Datasheet.

22.3 Design Requirement

All UPS components, i.e., rectifier, inverter, static switch, by-pass switch, isolation transformer associated controls shall be mounted in floor mounted, sheet steel panel. In case of 3ph output UPS, it shall be transformer less design. The panels shall be designed for continuous operation for the ambient conditions defined above in the design basis criteria. The battery shall be separately installed in battery racks. In case fans are required for cooling, N+1 Redundancy shall be provided to ensure rated output of the UPS.

Battery

The battery backup time, number and type of batteries shall be as specified in Data Sheet. The BIDDER shall choose the required voltage of the battery. The AH capacity of battery shall be chosen by BIDDER, based on the battery backup time / duty cycle, and minimum ambient temp. specified in Data Sheet and the guaranteed DC/AC efficiency of the UPS system offered.

BIDDER shall furnish calculation for sizing of the battery based on the requirements specified in Data Sheet.

Rectifier

The rectifier shall essentially be IGBT type for all ratings of three phase UPS. For single phase UPS full controlled full wave type thyristors rectifier shall be used. The thyristor type rectifier shall be 6 pulse/12 pulse design with input isolation transformer. For Redundant UPS design the two rectifier input isolation transformers shall have vector grouping and connections to ensure 12 pulse operation seen from the source side. The rectifier shall be provided with soft start feature. The rectifier shall have features for temperature compensation charging of the batteries

The rectifier shall be capable of supplying the inverter full load, in addition to charging the fully discharged batteries in 8 to 10 hours or as recommended by battery manufacturer and then maintain the battery on trickle charge mode. The rectifiers shall automatically share the load during parallel operation in case of common battery, as specified in Data Sheet.

Inverters

The inverter shall be of IGBT type. The same shall be of PWM (Pulse Width Modulation) type. The inverter system shall be complete with necessary filters to limit the harmonic distortions to the load. The system shall have features to prevent deep discharge of battery.

Static Switch

The static switch shall comprise thyristors connected in anti-parallel configuration, enabling loads on each branch circuit to be connected to the inverter of the other branch circuit or to the stand-by regulated AC supply.

The current rating of the static switch shall be not less than the continuous full load rating of the branch circuit and short time rating of 1000% for 10 milliseconds.

Automatic initiation of the transfer from a faulty branch circuit to either a healthy branch circuit or the stand-by regulated source shall be accomplished during following conditions:

(a) Inverter failure.

(b) Loss of inverter AC output.

(c) Load over current (in case of non-redundant UPS with static by pass to regulated supply).

Circuit Protection

The following devices shall be provided to protect the UPS system:

(a) AC input circuit breaker to Rectifier unit.

(b) AC input circuit breaker to supply stand-by transformer / voltage stabiliser.

(c) DC circuit breaker for battery output.

(d) Fast acting semiconductor fuses.

22.4 Indication and Annunciation

The UPS system shall be provided with necessary meters, mimic diagram, local indication / alarm conditions.

High resolution digital display unit shall be provided for continuous monitoring of the UPS operation. The control system shall operate on Windows or eqvt. platform. The following operating conditions shall be annunciated.

Alarm Indication:

(a) System fault

(b) Rectifier charger failure

(c) Inverter failure/ faulty

(d) Battery under voltage

(e) End of Battery Discharge

(f) UPS over temperature

(g) Over load

(h) Static transfer to stand-by

(i) Transfer inhibited

(j) Over load shutdown

(k) Emergency shutdown

(l) Battery circuit breaker / switch open

(m) AC Main failure

(n) AC stand-by source mains failure

(o) AC stand-by frequency out of range

(p) Manual bypass ON

(q) Fan failure

(r) Asynchronous condition

(s) Control power failure Status

Indication on Mimic:

(a) Mains on

(b) Rectifier on

(c) Battery on load

(d) Inverter on

(e) AC Stand-by source on

(f) Inverter on –load

(g) Manual by-pass on

(h) Load on static by pass.

Display of measurements:

(a) Inverter output phase-to-phase voltages

(b) Inverter output currents

(c) Inverter output frequency

(d) Voltage across battery terminals

(e) Rectifier input phase-to-phase voltages

(f) Rectifier input currents

(g) Active and apparent power

(h) Power factor

(i) DC voltage & Current

22.5 AC Distribution Board

The AC Distribution Board shall be supplied with UPS.

22.6 System Earthing

The VENDOR shall clearly bring out the earthing philosophy to be adopted for the UPS electronics, protective earthing (PE) and neutral earthing. The requirement of separate clean earth independent of the plant electrical system earth shall be clearly brought out. All metallic

non-current carrying parts of the Panel shall be bonded together and connected to the earth bus made of GI.

22.7 Tests on UPS

Routine tests on the complete UPS system shall be carried out as per relevant standards for each major sub-system in the UPS, viz., Rectifier, Inverters, batteries, stand-by supply etc.

Type and routine tests certificates for all components used in the UPS system shall be furnished. Tests for components shall be as per relevant standard specifications indicated above.

BIDDER shall furnish the quality assurance plan for the equipment offered. The quality assurance plan shall include bought out components and assemblies used in the UPS system.

System tests shall be performed on the completely assembled UPS system. System tests shall include frequency regulations, Voltage regulation, current limiting feature and harmonic content tests in addition to the tests to prove the functional requirements such as synchronisation with range of adjustments, transfer of static switches for conditions of loss of square wave, overload and under voltage conditions.

Endurance test on static switches shall be performed for not less than 10 transfer / retransfer cycles at full load.

Heat run test shall be carried out on each branch of UPS including bypass (if provided) and on overall UPS system at rated load under relevant ambient conditions for a period of 8 hours. This test shall be conducted as a routine test on all UPS being supplied.

22.8 Data to be furnished by vendor after award of contract

Drawing / Document for Approval:

- Detailed schematic diagram of the UPS system showing all components
- Bill of Material indicating rating & type designation of components.
- General Arrangement drawing showing overall dimensions, foundation fixing details, location of various devices, mimic diagram, list of protections, annunciation and meters, cable openings, etc.
- Battery Sizing Calculation
- Battery Drawings/documents as specified in battery Specification

Drawings / Documents for information

- Type test reports on components chosen.
- Quality assurance plan.
- Instruction manuals.

23. SAFETY REQUIRMENTS

Following shall be the minimum consideration for safety requirements:

(i) Providing and fixing M.V. danger notice plate of 200 mm X 150 mm, made of mild steel, atleast 2mm thick,and vitreous enamelled white on both sides,and with inscription in single red colour on front side as required.
(ii) Supply and fixing wooden framed covered with glass shock treatment chart printed on cloth in English ,Hindi & Local language (Odia).
(iii) Supply and providing ISI marked electrical 1.1 kV grade 3 mm thick anti-skid rubber mat, 2 x 1 mtr as per IS:15652-2006 with up to date ammendment.
(iv) ABC type duly refilled 6 Kg & ready to use
(v) Providing & fixing Fire Extinguishers as per IS Dry chemical poweder type -5kg
(vi) Providing & fixing of 'No Smoking' and 'No Unauthorized Entry' signboards in English and Hindi, Odia as per IPR- 1970.
(vii) Providing and fixing HT danger notice plate of 250 mm X 200 mm, made of mild steel,atleast 2mm thick,and vitreous enamelled white on both sides,and with inscription in single red colour on front side as required.
(viii) Supply and fixing in position 1000 mm wide rubber matting of 33 KV grade as per electricity rules. Thickness of rubber mat shall be as per latest IS Code.
(ix) Supply and fixing suitable size wooden framed covered with glass for Main Panel SLD in electrical room as per IE rules fixed to wall as required.
(x) Supply, installation, testing and commissioning of Standard First aid box complete with all accessories as required.
(xi) Supply of 33kV pair of hand gloves

LIST OF TECHNICAL SPECIFICATIONS TO BE FURNISHED BY BIDDER

The Contractor shall furnish the following details as a part of technical bid. Contractor shall furnish all relevant catalogues relevant to the equipment required in the proposed building for Electrical Installation Works.

1) COMPACT SUBSTATION

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
G	**1.0**	**ENCLOSURE SPECIFICATIONS**		
	1.1.	Make		
	1.2.	Applicable Standards		
	1.3.	Rated maximum power of substation	kVA	
	1.4.	Ambient Temperature	°C	
	1.5.	Type of Ventilation for		
		a) Normal Condition		
		b) Hot Condition		
	1.6.	Compartmentalized		□ Yes □ No
	1.7.	Fault level	kA, sec	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	1.8.	Rated temperature enclosure class		
	1.9.	Internal Arc withstand level		
	1.10.	Degree of protection		
		a) MV & LV compartment		
		b) Transformer compartment		
	1.11.	Enclosure material		
	1.12.	Thickness of sheet	mm	
	1.13.	Paint colour & finish		
	1.14.	Total dimensions of Compact Substation (H X W X D)	mm	
	1.15.	Weight	Kg	
	2.0	**CIRCUIT BREAKER**		
	2.1.	Type of circuit breaker		
	2.2.	Rated current	A	
	2.3.	Nominal system voltage	kV	
	2.4.	Maximum continuous voltage	kV	
R	2.5.	Power frequency withstand (one minute) voltage		
		a) Short circuit withstand	kV	
		b) Momentary withstand	kV	
	2.6.	Impulse 1.2/50micro sec withstand voltage	kV	
	2.7.	Trip coil consumption at rated voltage	Watt	
	2.8.	Type of closing mechanism		
	2.9.	Spring charging mechanism		
	2.10.	Spring charging motor power rating & voltage	Watt, Volt	
	3.0	**BUSBAR**		
	3.1.	Material		
	3.2.	Busbar cross section	Sq.mm	
	3.3.	Continuous current rating under site condition	A	
	3.4.	Busbar insulation		
	3.5.	Minimum clearance		
		c) Phase to phase	mm	
		d) Phase to earth	mm	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	4.0	**CURRENT TRANSFORMERS METERING & PROTECTION**		
	4.1.	Type (Bar/ Wound/ Any other)		
	4.2.	Make		
	4.3.	Class of insulation		
	4.4.	Ratio		
	4.5.	Rated VA burden		
	4.6.	Accuracy class		
	5.0	**VOLTAGE TRANSFORMERS**		
	5.1.	Type		
	5.2.	Make		
	5.3.	Ratio		
	5.4.	Accuracy		
	5.5.	Type of insulation		
	6.0	**INDICATING METERS**		
	6.1.	Make		
	6.2.	Type		
	6.3.	Size		
	6.4.	Mounting, flush type or other		
	6.5.	Accuracy		
	6.6.	Range		
	6.7.	VA burden for each type		
	7.0	**PROTECTION RELAYS**		□ Electromechanical □ Solid state □ Numerical
	7.1.	Make		
	7.2.	Inverse time over-current relay		
	7.3.	Instantaneous over-current relay		
	7.4.	Thermal overload protection relay		
	7.5.	Earth leakage relay for use with core balance CT		
	7.6.	Earth fault relay for use in the residual circuit of main CTs		
	8.0	**TRANSFORMER PARTICULARS**		
	8.1.	Make		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	8.2.	Type		
	8.3.	Full load rating	kVA	
	8.4.	Type of cooling		
	8.5.	Rated percentage impedance	%	
	8.6.	Winding connections		
		a) HV		
		b) LV		
		c) Vector group		
	8.7.	Tap changer		On load / off load
		a) Total tapping range	%	
		b) Tapping steps		
		c) On HV/LV winding		
	8.8.	Method of earthing - LV		
	8.9.	Windings material		
	8.10.	Type of insulation		
	8.11.	1.2/ 50 micro impulse withstand		
		a) HV	kV	
		b) LV	kV	
	8.12.	One minute power frequency withstand voltage		
		a) HV	kV	
		b) LV	kV	
	8.13.	Maximum temperature rise of windings	°C	
	8.14.	Max guaranteed load loss at rated current at max winding temperature For ONAN / ONAF / AN / AF	kW	
	8.15.	No load losses at 100% rated voltage and frequency	kW	
	8.16.	Cooling equipment power loss	kW	
TRANSFORMER	8.17.	Magnetization current at rated voltage and frequency in percent of full load current	%	
	8.18.	Efficiency at max winding temperature at full load, at UPF and 0.8 PF lag at 75% load, at UPF and 0.8 PF lag at 50% load, at UPF and 0.8 PF lag	%	
	9.19.	Noise	dB	
	8.20.	Weight	Kg	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
LV COMPARTMENT	**9.0**	**CIRCUIT BREAKER**		
	9.1.	Circuit Breaker Type (Air break and / MCCB)		
	9.2.	Rated voltage	V	
	9.3.	Rated current	A	
	9.4.	Rated symmetrical breaking current at rated voltage (Indicate power factor)	kA at PF	
	9.5.	Rated short time withstand rating for 1 sec (For MCCB, BIDDER to indicate the time)	kA	
	9.6.	Operating mechanism type		
	9.7.	Rated operating duty		
	9.8.	Relationship between ICU, ICS & ICW	%	
	9.9.	Have electrical and mechanical anti-pumping features been provided	Yes / No	
	11.0	**FUSE**		
	11.1.	Make		
	11.2.	Type		
	11.3.	Rated voltage	V	
	12.0	**BUSBARS**		
	12.1.	Material		
	12.2.	Busbar cross section	Sq.mm	PH : Neutral :
L	12.3.	Continuous current rating under site conditions	A	
	12.4.	Busbar insulation		
	12.5.	Minimum clearance		
		a) Phase to phase	mm	
		b) Phase to earth	mm	
	12.6.	Short time rating (One Sec.)	kA	
	12.7.	Momentary rating (Peak)	kA	
	13.0	**CURRENT TRANSFORMERS**		
	13.1.	Type		
	13.2.	Make		
	13.3.	Ratio		
	13.4.	Accuracy		
	14.0	**VOLTAGE TRANSFORMERS**		
	14.1.	Make		
	14.2.	Ratio		
	14.3.	Accuracy		
	14.4.	Output per phase	VA	
	14.5.	Class of insulation		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	15.0	**INDICATING METERS**		
	15.1.	Make		
	15.2.	Type		
	15.3.	Size		
	15.4.	Mounting, flush type or other		
	15.5.	Accuracy		
	15.6.	Range		
	15.7.	VA burden for each type		
MISCELLANEOUS	16.0	DC SYSTEM		
	17.0	AUTOMATIC POWER FACTOR CONTROL (APFC) UNIT		
	18.0	SPARES		
	19.0	COMPLIANCE WITH SPECIFICATION		

2) 415V METAL ENCLOSED SWITCHGEAR

Sr. No	Description	Unit	Technical Particulars
1	**415 V Switchgear and Bus bar Ratings**		
(a)	Rated voltage phase and frequency		
(b)	System Neutral Earthing		
(c)	Maximum system voltage		
(d)	One minute power frequency voltage		
	i) Power circuits		
	ii) Control circuits		
	iii) Aux. Circuits connected to Sec of CTS		
(e)	Continuous current rating of Bus bars under site reference Ambient Temperature and type		
(f)	Bus bar insulation		
(g)	Reference Ambient Temperature		
(h)	Maximum Temperature of Bus bars, Droppers and Contacts at Continuous		

Sr. No	Description		Unit	Technical Particulars
	current rating under site ambient temperature			
(i)	Short Circuit current withstand for Bus bars and droppers (i) Short time 1 sec			
	(ii) Dynamic Rating			
2	**Switchgear Constructional Requirements**			
(a)	Type of Construction			
(b)	Thickness of sheet steel (i) Frame, Frame enclosures, doors, covers and partitions			
(d)	Colour finish shade			
(e)	Earthing bus	Material		
		Size		
	Earthing conductor	Material		
		Size		
(g)	Minimum clearances in air of live parts (i) Phase to Phase			
	(ii) Phase to Earth			
(h)	Cable entry to cubicles			
3	**Instrumentation Transformers**			
(a)	Current transformer			
	(i) Ratio			
	(ii) Burden			
	(iii) Accuracy Class			
(b)	Voltage transformer			
	(i) Ratio			
	(ii) Burden			
	(iii) Accuracy Class			
4	**Type of Starter for MCC Panel**			

3) LV CAPACITOR PANEL

S. N.	Description	Unit	Technical Particulars
i	General		

S. N.	Description		Unit	Technical Particulars
(a)	Make			
(b)	Rated Capacity		kVAR	
(c)	Rated voltage		V	
(d)	Rated frequency and phases			
(e)	Ambient temperature		^{o} C	
(f)	Cable gland required			
(g)	Type of cable			
(h)	Size of cable			
(i)	Cable entry			
ii	Constructional Requirement			
(a)	Thickness of sheet steel			
	i) Frame, Frame enclosures, doors covers and partition		Mm	
(b)	Degree of protection			
(c)	Colour finish shade			
(d)	Earthing bus	Material		
		Size	mm x mm	
(e)	Earthing conductor	Material		
		Size	mm x mm	
iii	Design Requirement			
(a)	Insulation level		kV (rms)	
(b)	Capacitor bank connection			
(c)	Short circuit withstand for busbars			
	i) Short time (1 sec)		kA (rms)	
	ii) Dynamic		kA (peak)	
(d)	Type of switching & capacitor			
(e)	Switching steps			
(f)	Rating of contactor			
(g)	Incomer switch current rating			
(h)	Busbars			

4) HV, LV POWER & CONTROL CABLES

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	11kV power cables	Control cables
1	Name of the Manufacturer				
2	Conductor(stranded/solid)				
2.1	Form circular/segmented				
2.2	Nominal diameter in mm				
2.3	Effective cross sectional area sq mm				
3	Whether cores identified by numeral for cable with five core and above.				
4	Whether incremental running lengths are marked on cable at every 1 m interval.	YES/NO			
5	Finished cable				
5.1	Diameter under armour in mm				
5.2	Diameter over armour in mm				
5.3	Overall diameter in mm				
6	Whether cables will carry ISI stamp.	YES/NO			
6.1	If not explain reasons				
7	Cable drums				
7.1	Length of cables in cable drum and tolerance				
7.2	Weight of cable drum without cables				
7.3	Weight of cable drum with cables				
8	Type of end sealing				
9					

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	**11kV power cables**	**Control cables**
9.1	Any other details the CONTRACTOR would like to furnish?				
9.2	List of deviations if any from specification, data sheet-A and applicable standard furnished				
9.3	Conductor screen				
9.4	Insulation				
9.5	Insulation screen				
9.6	Sheath				
9.7	Armour				

5) LIGHTING FIXTURES & ACCESSORIES

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
1.	Type	
2.	Rated Voltage	
3.	Expected Frequency	
4.	Operating Voltage Range	
5.	Power Factor	
6.	Operating Temperature Range	
7.	Working Humidity	
8.	Driver Type	
9.	Driver Efficiency	
10.	Driver Life	
11.	Protection required in Driver module	
f.	Short Circuit	
g.	Over Voltage	
h.	Over Temperature	
i.	Under Voltage	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
j.	String Open Protection	
12.	Luminaire IP Protection	
13.	Minimum Surge Protection	
14.	THD	
15.	Rated Minimum LED Life (L70)	
16.	Rated Minimum Driver Life	
17.	CRI	
18.	Junction temperature rise	
19.	Solder point temperature	
20.	Maximum temperature rise for Driver	
21.	Make of LED	
22.	Make of Driver	
23.	Operating Hours	
24.	Luminous Efficacy	
25.	System Efficacy	
26.	Colour Temperature	
27.	Illumination Regulation	
28.	Material used for following	
d.	Housing	
e.	Heat Sink	
f.	Clip / Fasteners	
g.	Diffuser	
29.	Maximum temperature of Heat sink	
30.	IK protection of Optic Cover	
31.	Wires used Inside Luminaries	
32.	Cable gland IP protection	
33.	Ratio of Horizontal to Vertical Illuminance	
34.	Glare index while viewing from critical observer position	
35.	Maintenance factor	
36.	Total of LED fixture	
37.	Wattage of each fixture	
38.	Total Power Consumption	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)		
39.	Horizontal Illumination	International Level	National Level	Practice Level
a.	Average			
b.	Uniformity (Min./Avg.)			
c.	Uniformity (Min./Max.)			
40.	Vertical Illumination			
a.	Average			
b.	Uniformity (Min./Avg.)			
c.	Uniformity (Min./Max.)			

6) LIGHTING SYSTEM EQUIPMENT

S.N.	Description	Unit	Technical Particulars
1	**LIGHTING DISTRIBUTION BOARDS AND LIGHTING PANELS**		
1.1	System Particular		
(a)	Voltage		
(i)	3 Phase, 4 wire 50 Hz system		
	Rated	V	
	Maximum	V	
	One minute withstand voltage	V	
(ii)	D.C. system		
	Rated	V	
(b)	System short-circuit level		
	(i) At 415 V, A.C.	kA (rms)	
	(ii) At 110 V.D.C.	kA (D.C.)	
(c)	Reference ambient temperature	deg C	
1.2	Indicate the type and routine tests to be carried out		
1.3	Distribution Board/Panels		
(a)	Main, floor mounted distribution boards		
(i)	Main Lighting distribution board(A.C.)		
	Make		
	Type		
	Degree of protection		

S.N.	Description	Unit	Technical Particulars
	Bus bar material		
	Bus bar current rating	A	
	Short circuit current rating	kA	
	Details of Incoming and Outgoing feeders		
	Cable entry		
	Location		
	Each complete board/panel, LxWxD		
	Dimensional drawing enclosed		
	Indicate the type and routine tests to be carried out		
(ii)	Emergency lighting panel (D.C.)		
	Make		
	Type		
	Degree of protection		
	Bus bar material		
	Bus bar current rating	A	
	Short circuit current rating	kA	
	Details of Incoming and		
	Outgoing feeders		
	Cable entry		
	Location		
	Each complete board/panel, LxWxD		
	Dimensional drawing enclosed		
	Indicate the type and routine tests to be carried out		
(iii)	Three phase DBs, wall/structure mounting		
	SLDB for indoor area		
	Make		
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(iv)	SLDB for outdoor area		
	Make		
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(v)	Paint Finish		

S.N.	Description	Unit	Technical Particulars
	Colour shade		
2	**MINIATURE CIRCUIT BREAKER**		
2.1	Make		
2.2	Type		
3	**EARTH LEAKAGE CIRCUIT BREAKER**		
3.1	Make		
3.2	Type		
3.3	Leakage Current I_N	mA	
4	**INSTRUMENT TRANSFORMERS**		
4.1	Make		
4.2	Type		
4.3	Output		
4.4	Accuracy Class		
5	**METERS**		
5.1	Make		
5.2	Type		
5.3	Accuracy Class		
6	**RELAYS (IF ANY PROVIDED)**		
6.1	Make		
6.2	Type		
6.3	Voltage Rating	V	
6.5	Setting Range	%	
	No. of Contacts		
	a)Normally open		
	b)Normally closed		
7	**FLAME PROOF ENCLOSURES**		
7.1	Make		
7.2	Suitable for use in hazardous area		
	a)Area classification		
	b)Gases/Vapour group		
7.3	Dimensional Drawings and Literature of each required equipment flameproof enclosure including fixing details enclosed	Yes/No	
7.4	Approval certificates of relevant statutory authorities enclosed	Yes/No	
8	**LIGHT CONTROL SWITCHES**		
8.1	Make		
9	**RECEPTACLE, PLUG AND SWITCH**		

S.N.	Description	Unit	Technical Particulars
9.1	Make		
10	**LIGHTING WIRES**		
10.1	Make		
10.2	Applicable Standard		
10.3	Voltage Grade	V	
10.4	Conductor Material	Cu/Al	
10.5	No.of Strands	mm^2	
10.6	Colour Coding		
11	**CONDUITS**		
11.1	Make		
11.2	Material		
11.3	Finish (Galvanised/Black Enamel/Any special anti-corrosive coating)		
11.4	Sizes offered and wall thicknesses		
11.5	Supply of necessary couplings, bends, tees, necessary for conduit routing included	Yes/No	
12	**JUNCTION BOXES**		
12.1	Make		
12.2	Material and Gauge		
12.3	Painted / Galvanised		
13	**CEILING FANS**		
13.1	Make		
13.2	Suspension Rod, Regulator and Switch included	Yes/No	

7) EARTHING & LIGHTNING PROTECTION SYSTEM

S. No.	Description	Material	Technical Particulars
1	**Main Earthing Grid**		
a)	Buried in earth	MS	
b)	Buried in floor slabs in buildings	MS	
2	**Conductor Leads To Equipment (above ground) – Substation Equipment & Structures**		
a)	Circuit Breaker	GS	
b)	Isolator	GS	

S. No.	Description	Material	Technical Particulars
c)	Transformers		Quantity - As per requirement & Sizes – As per Fault level calculations
	(i) Transformer neutral to bottom of tank	GS	
	(ii) From bottom of tank to earth grid	GS	
	(iii) Transformer tanks and radiator bank	GS	
	(iv) Marshalling Boxes	GS	
d)	Lightning arrester	GS	
e)	C.T. and P.T. body	GS	
f)	C.T. and P. T. secondary terminal box	GS	
g)	Towers and structures	GS	
h)	Fence posts and gates (Flex. braid)	GS	
i)	415V switchgear and capacitor panel	GS	
j)	Motors		
	(i) 415V Motors above 10 kW	GS	
	(ii)415V Motors up to 10 kW	GI wire	
	(iii)Fractional horse power motors	GI wire	
k)	Other Items		
	Capacitor panel, Battery charger panel, Main lighting D.B, Control panels and sub-lighting distribution boards	GS	
	Hand Rails	GS	
	Cable trays	GS	
	Tanks	GS	
	Junction boxes	GS	
	Lighting fixtures, receptacles, lighting conduits	GS	
	Push button stations, limit switches	GS	
	Crane rail	GS	
	Street lighting, flood lighting poles and junctions boxes	GS	
	Metallic non-current carrying structures	GS	
	Lightning Conductors	GS	
	Lightning protection down comers for building	GS	
	Lightning protection horizontal roof conductor for building	GS	
	Electrodes	GS	
	Pipe electrode	GS	

S. No.	Description	Material	Technical Particulars
	Maintenance free electrode	copper	

8) DG SET

Sr. No.	Description	Unit	Technical Particulars
1.0	GENERAL		
1.1	Name of manufacturer		
1.2	Engine model no.		
2.0	DESIGN FEATURES		
2.1	Continuous site output rating at generator terminals	**kW**	
2.2	Site output rating after auxiliary power consumption and transmission losses at switchyard/ bus bar terminals	**kW**	
2.3	Maximum site rating of engine (to be not less than 110% of the value indicated in item 2.1 above)	**kW**	
2.4	Standard engine rating (i.e., under standard atmospheric conditions as per ISO : 3046)	**kW**	
2.5	Derating factors for site conditions applicable on standard engine rating :	%	
	a) Altitude	%	
	b) Ambient temperature	%	
	c) Relative humidity at inlet temperature indicated in item (b) above	%	
	d) Cooling water temperature at the inlet of charge air cooler	%	
	e) Others	%	
	f) Total deration	%	
	N.B.		

Sr. No.	Description	Unit	Technical Particulars
	If the derating factors are different from those indicated in ISO : 3046 the BIDDER shall furnish details in deviations there from, justifying the deratings as applicable for the offered engine. Derating charts / calculationsshall be furnished along with the Bid for various atmospheric conditions		
2.6	Operating speed	RPM	
2.7	Main effective pressure (referred to kW output)	Pa(g)	
2.8	Types of operating cycle		
2.9	Mean piston speed	m/sec	
2.10	Design fuel oil		
2.11	Design lube oil		
3.0	ENGINE PERFORMANCE		
3.1	Continuous engine rating at site at generator (with specified fuel oil) with all coupled to engine	**kW**	
3.2	10% overload operation as per ISO 3046		**Yes/No**
3.3	Fuel consumption (with design fuel)		
	a) At 100% engine load	g / KW h	
	b) At 75% engine load	g / KW h	
	c) At 50% engine load	g / KW h	
3.4	Lube oil consumption at 100% engine load	g / KW h	
3.5	Primary jacket water temperature at engine inlet	^{o}C	
3.6	Primary jacket water temperature engine outlet	^{o}C	

Sr. No.	Description	Unit	Technical Particulars
3.7	Secondary cooling water temperature at heat exchangers inlet	^oC	
3.8	Secondary cooling water temperature at inlet to cooling tower,	^oC	
3.9	Secondary cooling water flow	$m^3/hr.$	
3.10	Maximum Secondary Water pressure drop through heat exchanger at flow value indicated in 3.9 above	Pa	
3.11	Secondary cooling water pressure at heat exchanger inlet	Pa	
3.12	Lube oil temperature at lube oil cooler outlet	^oC	
3.13	Lube oil temperature at lube oil cooler inlet	^oC	
3.14	Maximum period for which engine can operate without cooling water c		
	a) During cold start of engine	Secs.	
	b) During hot start of engine	Secs.	
3.15	Flue gas analysis at 100% load for specified fuel :		
	a) SO_2		
	b) Nox		
	c) Hydro carbon		
	d) CO_2		
	e) CO		
	f) Particulate matter		
	g) Others		
	h) SO_2 through stack	Kg/hr	
3.16	Governing Characteristics		

Sr. No.	Description	Unit	Technical Particulars
3.16.1	Maximum step load that can be applied to the engine at full rated speed, no load and at normal running temperatures	% of rated load	
3.16.2	Transient speed change resulting from applications of the load indicated in item 3.16.1 above	% of rated load	
3.16.3	Permanent speed change resulting from application of the load indicated in item 3.16.1 above	% of rated load	
3.16.4	Maximum recovery time to permanent speed change of 3.16.3	Secs.	
3.16.5	Transient speed rise resulting from a full load throw-off	% of rated load	
3.16.6	Permanent speed rise resulting from a full load throw-off	% of rated load	
3.16.7	Maximum recovery time to reach permanent speed rise value indicated in item 3.16.6 above	Secs.	
3.16.8	Transient speed change resulting from a change of load, both ON and OFF, by any step of 25% of the rated full load	% of rated load	
3.16.9	Permanent speed change resulting from change of load, both ON and OFF, by any step of 25% of the rated full load	% of rated load	
3.16.10	Recovery time for attaining permanent speed change value indicated in item 3.16.9	Secs.	
3.16.11	Steady load speed band	% of rated load	
3.17	DG set starting time i.e., ready to take load after “start” impulse	Secs.	
3.18	Maximum noise level at …….metres from equipment outline	dBA	
3.19	Maximum vibration level (peak to peak)	mm/secs.	

Sr. No.	Description	Unit	Technical Particulars
4.0	GENERATOR PERFORMANCE		
4.1	Generator efficiency at 100% rated load	%	
4.2	Generator efficiency at 75% rated load	%	
4.3	Generator efficiency at 50% rated load	%	
4.4	Generator efficiency at 25% rated load	%	
4.5	Voltage regulator response	%	
4.6	Excitation at full load and under specified variation of voltage and speed		
5.0	ENGINE CONSTRUCTION FEATURES		
5.1	Engine model No.		
5.2	No. of strokes		Two / Four Strokes
5.3	No. of cylinders		
5.4	Arrangement of cylinders		Inline / Vee Type
5.5	Cylinder bore	mm	
5.6	Piston stroke	mm	
5.7	Compression ratio		
5.8	Cylinder block :		
	a) Material of construction		
5.9	Crank case :		
	a) Material of construction		
5.10	Cylinder head :		
	a) Material of construction		
5.11	Cylinder liner :		
	a) Material of construction		
5.12	Crank shaft :		
	a) Forged / cast		

Sr. No.	Description	Unit	Technical Particulars
	b) Material of construction		
5.13	Crank shaft main bearings:		
	a) Nos. provided		
	b) Material of construction		
5.14	Piston :		
	a) Type		
	b) Material of construction		
5.15	Piston rings:		
	a) Material of compression rings		
	b) Material of oil rings		
5.16	Piston pin (Gudgeon pin):		
	a) Material of construction		
5.17	Connecting rod :		
	a) Material of bearings		
	b) Lining for bearing materials		
5.18	Camshaft:		
	a) Material of bearings and lining details		
	b) Mode of driving from crankshaft		
5.19	Engine valves :		Inlet Exhaust Starting Valve Air Valve
	a) Nos. provided per cylinder		
	b) Material of valve body		
	c) Material of valve seat		
	d) Type of valve cooling		
5.20	Oil pan:		

Sr. No.	Description	Unit	Technical Particulars
	a) Capacity upto normal working level	m^3	
	b) Material of construction		
5.21	Gaskets – Material of construction :		
	a) Between cylinder head and cylinder block		
	b) Between cylinder block and oil pan		
	c) Between cylinder block and end corners		
5.22	Fly wheel with cover		Provided / Not provided
5.23	Fuel injection System :		
	a) Type of system		
	b) Engine driven fuel feed pump provided		Yes / No
5.24	Governing system type		
5.25	Foundation details :		
	a) No. of holding down bolts		
	b) Anti-vibration springs with visco dampers		Yes/ No
6.0	ENGINE SYSTEMS		
6.1	Fuel Oil system :		
a	Fuel Oil tanks (For each tank)		
	a) Nos. provided		
	b) Working capacity of each tank	m^3	
	c) Size of tank :		
	i) Rectangular tank	mxmxm	
	ii) Cylinder tank	Dia(m)xHt(m)	
	d) Material of construction		
	e) Location		

Sr. No.	Description	Unit	Technical Particulars
b	Motor operated transfer pumps furnished		Yes / No
	(For each pump)		
	a) Nos.		
	b) Type		
	c) Capacity	m^3/hr.	
	d) Motor Rating	KW	
c	Fuel oil filters		2 x 100 % Simplex / 1 x 100 % Duplex
d	Maximum pressure drop across filters in clogged condition		
e	Through put capacity of fuel oil treatment plant at specified viscosity of fuel oil		
f	No. of fuel oil treatment units provided.		
g	Separating temperature		
6.2	Lube oil System :		
a	Type and grade of lube oil to be used		
b	Capacity of lube oil sump below cylinder block / crane case at normal working level	m^3	
c	Lube oil tanks external to engine (For each tank)		Yes / No
d	a) Capacity	m^3	
e	b) Material of construction		
f	c) Location		
g	Engine driven / Motor Driven lube oil pump :		
	a) Nos.		
	b) Type		

Sr. No.	Description	Unit	Technical Particulars
	c) Capacity	m^3/hr.	
	d) Motor Rating	KW	
h	Lube oil cooler :		
	a) Type		
	b) Cooling fluid		
	c) Secondary Cooling Water flow / Primary Jacket Water flow	m^3/hr.	
i	Lube oil filters :		
	a) Type		2 x 100 % Simplex / 1 x 100 % Duplex
	b) Maximum allowable pressure drop across filter in clogged condition		
j	Lube oil heater :		
	a) Provided		Yes/ No
	b) Type		
	c) If electric, indicate power rating	kW	
k	AC motor driven priming pump :		
	a) Nos. provided		
	b) Type		
	c) Capacity	m^3/hr.	
	d) Head	mlc	
	e) Motor rating	kW	
l	Quantity of lube oil required for initial filling	m^3	
m	Through put capacity of lube oil treatment plant at specified viscosity of fuel oil		

Sr. No.	Description	Unit	Technical Particulars
n	No. of lube oil treatment units provided.		
o	Separating temperature		
6.3	Primary Jacket Water System		
a	Type of cooling		Radiator cooled / Secondary cooling water cooled
b	Quality of water		
c	Quantity of water required for initial filling	m^3	
d	Makeup water quantity	m^3/hr.	
e	Expansion tank :		
	a) Working capacity	m^3	
	b) Size :		
	i) Rectangular	mxmxm	
	ii) Cylindrical	Dia(m)xHt(m)	
	c) Material of construction		
	d) Inner coating details		
f	Jacket Water Pump and jacket water pre heating pump		
	a) Type		Engine driven / AC motor driven
	b) Capacity	m^3/hr.	
	c) Head	mlc	
	d) Mode of driving off engine crank shaft		
	e) Motor Rating	KW	
g	Radiator (if required)		
	a) Type		

Sr. No.	Description	Unit	Technical Particulars
	b) Overall size		
	c) Materials of construction :		
	i) Tubes		
	ii) Fins		
	iii) Header		
	d) Location		
	e) Radiator fan :		
	i) Tip diameter	mm	
	ii) Max. speed	rpm	
	iii) Flow at above speed	m^3/hr.	
	f) Air temperature rise across radiator		
	g) Mode of drive from engine crank shaft		
	h) Material of construction of fan :		
	i) Blades		
	ii) Hub		
	i) Air ducting details :		
	i) Material of construction		
	ii) Inside clear dimensions	mmxmm	
	iii) Type of fixing arrangement between air duct and radiator		
	j) Fan guard provided		Yes / No
	k) Fan motor rating	KW	
h	Heat Exchanger :		
	a) Designation		
	b) Type		Shell & tube type / plate type
i	Jacket water heater :		

Sr. No.	Description	Unit	Technical Particulars
	a) Nos. provided		
	b) Type		
	c) If electric, power required	kW	
6.4	Air intake system :		
a	Intake silencer type		
b	Air cleaner :		
	a) Type		Wet/ Dry
	b) Nos. provided		
	c) Design air flow	m^3/hr.	
	d) Materials of construction:		
	i) Body and cover		
	ii) Filter element		
	e) Type of oil to be used for wet type		
	f) Frequency of oil cleaning filter element cleaning		
	g) Location		
c	Turbocharger (exhaust gas driven) :		
	a) Speed	Rpm	
	b) Air pressure at outlet	Pa(g)	
	c) Air temperature at outlet	^oC	
	d) Maximum air flow	Nm^3/hr.	
	e) Blade material		
	f) Casing material		
d	Supercharger (engine driven) :		
	a) Type		Roots type
	b) No. of lobes		Two / Three
	c) Speed	rpm	

Sr. No.	Description	Unit	Technical Particulars
	d) Air flow	$Nm^3/hr.$	
	e) Air outlet pressure	Pa(g)	
	f) Air outlet temperature	^oC	
	g) Material of construction :		
	i) Lobes		
	ii) Casing		
	iii) Shafts		
	iv) Bearings		
	v) Seals		
	vi) Timing gears		
	b) Type of drive from engine crank shaft		
e	Charge air cooler :		
	a) Type		
	b) Nos. provided		
	c) Cooling water type		
	d) Design water flow required	$m^3/hr.$	
	e) Pressure drop at above flow	mlc	
	f) Inlet water temperature	^oC	
	g) Temperature rise	^oC	
	h) Charge air temperature at cooler outlet	^oC	
	i) Material of construction :		
	i) Tubes		
	ii) Fins		
	iii) Cover		
	iv) End plates		
6.5	Exhaust gas system:		

Sr. No.	Description	Unit	Technical Particulars
6.5.1	No. of streams provided		
6.5.2	Exhaust silencer		
	a) Nos. provided per exhaust pipe		
	b) Type		
	c) Location		
6.5.3	Exhaust Duct		
	a) Size		
	b) Material		
6.5.4	Lagging details :		
	a) Lagging material		
	b) Lagging thickness		
6.6	Air starting system :		
6.6.1	Nos of compressors motor driven		
6.6.2	Nos of compressors diesel engine driven		
6.6.3	Compressor details		
	a) Manufacturer		
	b) Type		
	c) Rating		
	d) Speed	rpm	
6.6.4	Air receivers / air bottles		
	a) Nos. provided		
	b) Air capacity of each air receiver	m^3	
	c) Normal air pressure in air receiver	Pa(g)	
	d) No. of starts of engine from each receiver		
6.6.5	Normal air pressure for starting	Pa(g)	

Sr. No.	Description	Unit	Technical Particulars
6.6.6	Minimum air pressure for starting engine	Pa(g)	
6.6.7	Quantity of free air per start	Nm^3/hr.	
6.7	Common base frame for engine and generator:		
	Type		
	Material of construction		
6.8	Engine generator coupling :		
a	Type		
b	Whether fixed directly to fly wheel :		Yes / No
c	Clutch with engaging / disengaging arrangement provided?		Yes / No
d	Coupling guard material		
e	Coupling guard for clutch provided ? If 'Yes' indicate type		Yes / No
7.0	GENERATOR AND ACCESSORIES		
7.1	Name of manufacturer		
7.2	Design rating	kW	
7.3	Continuous output rating	kW	
7.4	Maximum rating	kW	
7.5	Power factor		
7.6	Rated voltage	Volts	
7.7	Rated current/ phase	Amps	
7.8	Speed	rpm	
7.9	Frequency	C/s	
7.10	Field current at rated output and voltage	Amps	
7.11	Insulation class :		

Sr. No.	Description	Unit	Technical Particulars
	a) Stator		
	b) Rotor		
7.12	Temperature rise above ambient of 45°C (by thermometer):		
	a) Stator	°C	
	b) Rotor	°C	
	c) Cores	°C	
7.13	WR^2 of rotating mass in diesel engine, generator, exciter, etc.	kgm^2	
7.14	Generator parameters :		
7.14.1	Synchronous reactance Xd:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.2	Transient reactance X'd:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.3	Sub-transient reactance X"d:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.4	Zero sequence reactance Xo	Ohms	
7.14.5	Negative sequence reactance X2	Ohms	
7.14.6	Open circuit transient time constant	secs.	
7.14.7	Open circuit synchronous time constant	secs.	
7.14.8	Open circuit field time constant T	secs.	
7.14.9	Short circuit ratio		
7.14.10	Resistance of field winding at operating temperature	Ohms	

Sr. No.	Description	Unit	Technical Particulars
7.14.11	Resistance of stator winding at operating temperature	Ohms	
7.15	Generator performance :		
7.15.1	Full load losses	kW	
7.15.2	Armature copper loss	kW	
7.15.3	Rotor copper loss	kW	
7.15.4	Core loss	kW	
7.15.4	Stray losses	kW	
7.15.5	Efficiency :		
	a) ¼ load	%	
	b) ½ load	%	
	c) 3/4 load	%	
	d) Full load	%	
8.0	MAIN EXCITER		
8.1	Rated voltage	Volts	
8.2	Rated current	Amps	
8.3	Ceiling voltage at zero load and rated speed	Volts	
8.4	Ceiling voltage at rated current and rated speed	Volts	
8.5	Excitation system response ratio		
8.6	Insulation class:		
	a) Stator		
	b) Rotor		
9.0	AUTOMATIC VOLTAGE REGULATOR		
9.1	Type		
9.2	Burden of AVR on CTs and PTs		
	a) CTs	Va	

Sr. No.	Description	Unit	Technical Particulars
	b) PTs	Va	
9.3	Dead band (if any)		
9.4	Field discharge resistor	Ohms	
9.5	Type and rating of field breaker		
10	TESTING		
10.1	BIDDER to indicate whether the following tests will be conducted :		
10.2	Dimensional accuracy of individual components		Yes / No
10.3	Hydro testing of all jacket water passages		Yes / No
10.4	Hydro testing of all lube oil lines		Yes / No
10.5	Hydro testing of fuel oil lines		Yes / No
10.6	Checking all lube oil passage for free flow of oil		Yes / No
10.7	Rig testing of governor assembly		Yes / No
10.8	Rig testing of individual injectors		Yes / No
10.9	Shop testing of engine with all the engine driven equipment in position		Yes / No
11	WEIGHTS		
11.1	Weight of fully assembled engine	kg	
11.2	Weight of generator	kg	
11.3	Weight of common base frame	kg	
11.4	Weight of fully assembled engine generator	kg	
11.4	GD2 for DG set	Kg/m^2	
11.5	Weight and name of heaviest part to be lifted during : a) Erection b) Maintenance	kg	

Sr. No.	Description	Unit	Technical Particulars
12	DIMENSIONS		
12.1	Overall dimension of engine		
12.2	Overall dimension of generator		
12.3	Height and name of longest part to be lifted during maintenance		

. LIST OF DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

Following drawings, calculations & schedules shall be submitted to Employer/ DISCOM for approval before procurement, fabrication and Installation of equipments at site,

S.N.	Deliverables
1.0	Design Basis Report
2.0	Single Line Diagram of Complete Electrical System based on the design criteria.
3.0	Drawing details, Bill of quantities for conversion yard comprising of 4 pole structure, GOD, DO Fuse, LA, etc
4.0	33k Ring Main Unit
a	General arrangement drawing shall indicate the overall dimensions, net weights, crane requirements, foundation details and the general constructional features.
b	General arrangement drawing of the showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, crane lift , size of lifting lugs and eyes, and bill of materials etc.
c	Quality Action Plan
5.0	33kV Ring Network Route layout indicating number of pipes, electrical cable chamber location, RMU connection details. Technical Datasheet for DWC HDPE, RCC pipes with QAP.
6.0	Electrical Substation General Arrangement and sectional Layouts of substation showing locations of various Equipment including Compact substation, DG Sets , cable trenches, 33 kV VCB Switchgear Panel, LT Panels, control & relay panels and other allied equipments and associated systems.
7.0	Bill of quantities for 33/0.433kV Substation
8.0	33kV/0.433 kV Compact Substation
a)	General arrangement drawing shall indicate the overall dimensions, net weights, quantity of oil, crane requirements for assembly and dismantling of transformers, and the general constructional features.
b)	General arrangement drawing of the transformer showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, jacking pads, crane lift for untanking, size of lifting lugs and eyes, clearances between HV terminals, between LV terminals, between HV and LV terminals, between HV & LV terminals and ground and bill of materials etc.
c)	Valve schedule, Rating, diagram and terminal marking plates, complete with polarity and vector group.
d)	OCTC/OLTC cabinets: schematic circuit diagram and actual detailed wiring diagram giving terminal numbers.
e)	Bushings Plan, elevation, terminal details, mounting details, make and type number, current and voltage rating, creepage distances and principal characteristics.

S.N.	Deliverables
f)	Control wiring diagram for marshalling box.
g)	QAP
9.0	DG Sets
a)	General arrangement drawing shall indicate the overall dimensions, net weights and the general constructional features.
b)	General arrangement drawing of the DG Set showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, and bill of materials etc.
c)	Control wiring diagram for Synchronizing / AMF Panel
10.0	Cabling system
a.	Details of Installation of Cables in Trenches, on cable trays, racks directly buried etc., at all locations as specified including cable trays.
b.	33kV & 1.1kV Cable routing layout inside and outside the building.
c.	Bill of quantities of LT cables, lugs and glands & HT Termination Kits.
d.	33kV Cable termination and mounting Kit Layout drawing.
11.0	Earthing system
a)	Detail calculations of earthing network including main grid calculations.
b)	Earthing notes including detail write up and drawings of earthing conductor layout, equipment & structural earthing, joints, cable earthing, instrument earthing and special earthing.
c)	Details such as material, sizes, etc. of the earth conductor and electrode pits
d)	Earthing layout drawing showing interconnection of equipment earthing to the grid and earth pits
12.0	Lighting System
a.	Detailed Room wise Lighting Layout with type of fixture details and Circuit diagram showing phase wise load distribution and interconnection between switches, fixtures, Lighting panel, receptacles etc & Detailed lux level calculations.
b.	Conduit layout showing room wise routing of wires from lighting panel to lighting fixtures, receptacles etc.
c.	Lighting fixing arrangement, mounting structure details etc.for street lighting, landscape lighting and outdoor area lighting.
d.	Design Basis Report, Lighting Calculations for Complete Auditorium
e.	Technical Datasheet for lighting fixtures, pole, feeder pillar, junction box, etc. with type test reports and QAP.
13.0	VCB / LBS/ LT Switchgear

S.N.	Deliverables
a)	Design Calculations for Bus bar sizing, CT Sizing of all type etc. for each Switchboard along with a copy of relevant standard referred for the same
b)	Guaranteed Technical Parameters
c)	Equipment GA & Section drawings with dimensions, clearances, locations of components- CT, Terminals, etc. of each type of switchboard with component layouts like LV Compartment, etc with general notes
d)	Base frame and Foundation GA drawings with dimension and details
e)	Electrical Control drawing for all panels with general notes like sizes, type, Material details and other details
f)	Bill of material along with make, quantity, model no and ratings
g)	All the Type Test certificates to prove the compliance with the requirements and submit certificates before award of contract.
14.0	All civil drawings related to substation building & foundation of all the electrical items.
B)	**Calculations**
a)	Distribution Transformer , DG Sizing Calculations
b)	Fault level Calculations
c)	Co-ordinated protection study with latest available version of ETAP software.
d)	HT & LT cable sizing
e)	Lightning protection Calculations
f)	Earthing Sizing Calculations
g)	Room wise Lighting Calculation
h)	Stadium lighting calculation
i)	External lighting calculation
j)	Capacitor Sizing Caculation
C)	**Schedules**
a)	Cable Schedule
b)	Protection Relay Setting Schedule
c)	Interconnection schedule
d)	Junction Box Schedule

All equipment/system sizing calculations/drawings shall be submitted to the Employer for approval whether specifically mentioned or not.

2 Completion and Post Completion Activities

Mechanical completion is said to occur, when all erection/installation and commissioning of all electrical works and minor civil works under the scope of the Contractor are completed to the satisfaction of the Client's Representative with

a) All installation alignment checks.

b) All panels and equipment erected, grouted, with all cabling and wiring, terminations, routing, clamping, dressing, tagging, and ferruling duly completed including continuity and megger testing, and all installation checks.

At the stage of Mechanical completion, the Contractor shall ensure that all physical, aesthetic and workmanship aspects are totally completed, and the plant is fit and sound for undertaking pre-commissioning checks followed by commissioning.

Upon achieving mechanical completion, the Contractor shall notify the Client of such mechanical completion upon which the Client shall proceed with the checking of the works.

The Client may inform the Contractor regarding deficiencies for rectification by the Contractor within a jointly agreed period before the pre-commissioning checks could be undertaken. Alternately the Client, when the defects are of minor nature may undertake the pre-commissioning checks, permitting the Contractor to concurrently undertake rectification of such defects. Rectification of all defects, so notified by the Client, to his satisfaction shall be a prerequisite to issue of Taking over Certificate.

3 Testing and Commissioning

The Contractor shall carry out commissioning tests in the presence of the Client's representative. The evaluation of test results and decision passed by the Client's representative regarding the test results will be final and binding on the Contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the Contractor, if so desired by the Client's representative at no extra cost.

The completion checks and commissioning tests to be carried out shall include, but not be limited to, those described in subsequent paragraphs, as applicable to the individual equipment/system.

All checks and tests shall be as per the Manufacturer's drawing manuals, relevant codes of installation and commissioning checklists described in subsequent paragraphs.

Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards / International Standards. All tests to be carried out in the presence of Client's representatives.

a) Switchboard: Power frequency high voltage test, IR test, operation tests

b) Relays: Check internal wiring, relay settings

c) Cables

- All new LT cables shall be megger tested before terminating / jointing. After terminations / joints shall be megger tested by 1000V megger.
- All HT cables shall be megger tested before terminating / jointing. After terminations / joints shall be megger tested by 5000V megger.
- Cable core shall be tested for

- Continuity

- Absence of cross phasing

- Insulation resistance to earth

- Insulation resistance between conductors

d) Earthing System

Continuity of all conductors and joints shall be checked. The Client's representatives may ask for earth continuity tests, earth resistance measurements and other tests, which in his opinion are necessary, to prove that the system is in accordance with design, specification, code of practice and CEA Regulations 2010. Earth resistance value should be not greater than one (1) ohm or as per local regulatory requirements, the stringent one to be applicable.

e) Lighting System

Commissioning tests stipulated in applicable standards and code of practice covering all lighting system equipment

The Contractor shall carry out insulation resistance tests by a megger of following rating

Control circuits up to 220 V 500 V megger

Power circuits up to 1.1 kV 1000 V megger

In general, the following checks shall be carried out on all the equipment/systems, as applicable.

a) Name plate details according to approved drawings/ specifications
b) Any physical damage or defect and cleanliness
c) Tightness of all bolts, clamps and connections
d) Oil leakages and oil level
e) Condition of accessories and their completeness
f) Clearances
g) Earthing connections
h) Correctness of installation with respect to approved drawings/specifications
i) Lubrication of moving parts
j) Alignment
k) Correctness and condition of connections

4 Commissioning Tests

The following commissioning tests are to be carried out on all the equipment/systems, as applicable and as desired by EMPLOYER/ STATUTORY requirements.

a) Insulation resistance measurement of equipment, accessories, cabling/wiring etc.

b) Dielectric tests on equipment, accessories, cabling/ wires etc.
c) Phase sequence and polarity
d) Voltage and current ratios
e) Vector group
f) Resistance measurement of winding, contacts etc.
g) Continuity tests
h) Calibration of indicators, meters, relays, etc.
i) Control and interlock checks
j) Settings of equipment and accessories
k) Checking of accuracy/error
l) Checking of operating characteristics, pick-up voltages and currents, etc.
m) Operational and functional tests on equipment, accessories, control schemes, alarm/trip/indication circuits, etc.
n) Operational Checks for all the equipments for Auto and Manual mode..
o) Measurement of guaranteed/approved design values including lighting levels, earth resistance measurement, etc.
p) Complete commissioning checks of the system

5 Specific Tests to be carried out for various Equipments are as follows;

HT SWITCHGEAR PANELS

a) Check of electrical wiring.
b) Tests on auxiliary and control circuits.
c) Check of electrical operation of safety (interlocking, automatic changeover, Local / Remote operations in test as well as service position including all electrical interlocks etc).
d) Check of mechanical operations (insertion and withdrawal of removable parts, locks and interlocks system, operation of safety shutters, Anti pumping device operation etc.).
e) Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits
f) Check of setting of all protective and measurement devices (e.g. protection relays, smart devices, etc...).
g) IR values of power and control circuits
h) Panel indication, annunciation, space heater circuits
i) Spare contact for customer use

CONTROL CIRCUIT

a) Operational test of control circuits to be tested as per schematic drawing.
b) Indications/Alarm/Annunciation circuit to be tested as per control schematic drawing.
c) Check for panel space heater and illumination circuits.

LT SWITCHGEAR PANELS

a) Check of electrical wiring.
b) IR Values of power circuits & control circuits
c) Tests on auxiliary and control circuits.
d) Check of electrical operation of safety (interlocking, automatic changeover, Remote closing / Tripping circuits etc…).
e) Check of mechanical operations (insertion and withdrawal of removable parts, locks and interlocks system, operation of safety shutters, charging - closing - tripping of breaker etc..).
f) Check of setting of all protective and measurement devices (e.g. protection relays, smart devices, Secondary injection testing of protective relays/releases, Trip circuit healthiness and tripping through relays/ release etc...).
g) Indication / Annunciation / Panel space heater circuit / Space contacts for customer use
h) CT testing for polarity, ratio, IR values and magnetization for class PS characteristics
i) PT testing for ratio, IR values
j) Testing of modules for DOL/ Star-Delta/ATS/ Soft Starter starting or any other starting method as per the schematic drawings applicable.

HV & LV POWER CABLE, CONTROL CABLE & CABLE ACCESSORIES

a) IR Values before Hipot
b) Hi Pot test for MV & HV cables.
c) IR Values after Hipot

INDUCTION MOTOR

a) Measurement of insulation resistance on motor windings, built-in RTDs, anti-condensation heaters and bearing insulation, if any.
b) Tests on auxiliary and control circuits-Interlocks and simulation tests Auto/ Manual and local / remote operations
c) Bump start to check direction of rotation to match with driven equipment. Bump start shall be performed with motors uncoupled to prevent damage to equipment by reverse operation.

EARTHING SYSTEM

a) Earthing resistance of each electrode
b) Earth continuity check.
c) Overall resistance of earthing installation.

LIGHTING SYSTEM

a) Check of electrical wiring.

b) Functional tests.

c) Lux level measurement for each area.

5.1 APPLICABLE PERMITS

The Contractor shall obtain, as required under the Applicable Laws, the following Applicable Permits:

(a) Liasoning and approval from State Electricity Board / DISCOM to complete the work.

(b) Any other permits, clearances or approvals required under Applicable Laws.

(c) It shall be the Contractor's responsibility to arrange for inspection of all electrical equipments by the inspector or local authority. However, the actual deposited fees, if any for the inspection shall be borne by the contractor. The Contractor shall also be responsible for follow up action and obtain and deliver to the Owner/Employer the license/ permit required under the local/ provincial / national regulations/bye-laws free of cost. Nothing extra whatsoever on this account shall be paid to the contractor.

List of Vendors

Sr. No.	Material/ Equipment	Vendor
1.	Switchgear / Switchboard MV–VCB / RMU/ LBS	Siemens ABB Schneider Electric
2.	Compact Substation	Siemens ABB Schneider Electric
3.	Distribution Transformer	Schneider Electric Crompton Greaves Limited Transformers & Rectifiers India Limited C&S
4.	Static Power Meter & Logger (Trivector Meter)	As per DISCOM Company
5.	Sandwiched Type Bus Duct	Legrand L & T Schneider C&S ABB Anant Powertech
6.	Protection Relays (Numeric / Electro mechanic Type)/ Auxiliary relays)	ABB Schneider Electric Siemens Alstom GE
7.	Potential & control Transformer (CT/PT)	Gilbert & Maxwell Precise Kappa Pragati Anant Powertech

Sr. No.	Material/ Equipment	Vendor
8.	Current Transformer (Cast Resin Epoxy Coated)	Gilbert & Maxwell Precise Kappa Pragati Anant Powertech
9.	Electronic Digital Meter (A/V/PF/HZ/KWH) /MFM with LCD/LED Display.	Schneider Siemens Secure Socomec L & T ABB
10.	HRC Fuse and Fuse Fitting	ABB GE Siemens L&T
11.	ACB / MCCB/ Contactors	ABB Schneider Siemens L&T
12.	Change over switch (automatic/ manual)	HPL Hager ABB Socomec GE
13.	Thermister relay	Alstom/ Minilec/ Siemens
14.	Push Buttons	ABB L&T

Sr. No.	Material/ Equipment	Vendor
		Schneider Siemens BCH
15.	A. Power Distribution Panels & Boards Totally Type Tested Assembly (TTA) (As Per IEC61439- 1 & 2). To be sourced directly from OEM or authorized licensed partner. To be manufactured at manufacturer's own factory.	Advance Panels & Switchgears (P) Ltd. Adlec Power Pvt Ltd Jackson C&S Electric Ltd MOBY ELETROTECH PVT LTD
	B. Power Distribution Panels & Boards (Non TTA)	OEM of the following: Siemens Schneider ABB L&T C&S
16.	Switches, Time Delay Relay	Schneider Siemens Hager Legrand
17.	Indicating Lamps	Siemens Schneider ABB L&T BCH Esbee
18.	HT Power Cables	Universal KEC International

Sr. No.	Material/ Equipment	Vendor
		CCI Polycab KEI
19.	LT Power & Control Cables	Universal KEC International CCI Polycab Finolex
20.	HT/ LT Jointing Kit & Termination Kit	Birla-3M Raychem M seal
21.	Termination (Lugs)/ Cable Glands(Double compression)	Commet Dowell Jainson
22.	Selector Switches	Kaycee ABB Siemens Schneider
23.	Alarm Annunciators (solid state type with LED illumination) / Facia Annunciator	Industrial Instruments & Controls Minilec Alstom ICA
24.	Cable Management Systems-Raceways/Floor Boxes/ Trunkings , Cable trays	Legrand OBO-Betterman MEM
25.	Earthing strips	MARS MEM OBO STEELCO

Sr. No.	Material/ Equipment	Vendor
26.	Cable tray hangers and Supports	Gripple Hilti
27.	MS Black Stove Enameled ERW Conduits/GI pipes(ISI Approved) & accessories	AKG RMCON Precision TATA Steel
28.	UPVC Conduit/JB/flexible conduit / tees/ Bevels, elbow & accessories	AKG Plaza Avon Plast Precison
29.	Copper Conductor PVC Insulated Wires/ Stranded Flexible Wires (FRLS) / HFFR (including panel wiring)	Finolex RR Kabel LAPP India Polycab
30.	Non-insulated Copper Earthing conductors	Gupta Industrial Corporation (Vasai, Palghar) Bharat Wires & Ropes Diamond Cables
31.	Modular Switches, Socket Outlets And Wiring Accessories With Moulded Cover Plate.	Legrand Schneider MK Crabtree
32.	Metal Clad Plug & Socket (Industrial)	Legrand Schneider Neptune (Balls)
33.	MCB/RCCB/ SPD/RCBO/ MPCB	Legrand Schneider Siemens ABB

Sr. No.	Material/ Equipment	Vendor
		EATON
34.	Distribution Boards(MCB DBs)	Legrand Schneider Siemens ABB L & T EATON
35. a.	Light Fixtures-General	Wipro Philips Crompton Greaves Bajaj
b	LED / Driver	Cree Nichia Philips Lumiled Osram
36.	Exit lights	Prolite Legrand Philips Zumtobel
37.	Ceiling Fan (5 star rating)	Crompton Bajaj USHA ORIENT Havells
38.	Exhaust Fans (5 star rating)	Crompton Almonard

Sr. No.	Material/ Equipment	Vendor
		Havells Orient
39.	Street & Landscape Lighting	Schreder Wipro BAJAJ Philips Lighting technologies Keselec
40.	MS Tubular / Octagonal / Decorative Poles	Bajaj Schreder Valmount K-lite Keselec
41.	Lightning Protection System	DEHN Elpro Oblum Crompton Greaves
42.	Lightning & Surge Voltage Protection	ABB Hager OBO Betterman DEHN
43.	Fire Sealant & Fire Retardant Paint	3 M India Ltd. HILTI Promat
44.	Fire Barriers / Sealing	Brattberg Roxtec Signum Navell

Sr. No.	Material/ Equipment	Vendor
		Multikil
45.	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
46.	Insulating mats	Electromat Dozz Raychem RPG
47.	Terminal Blocks /connectors	Jainson Elmex Connect well Wago
48.	Elevator/ Escalators	Thyssenkrupp Otis Kone Mitshubishi Johnson
49.	Single Phase Preventers	Minilec Siemens Schneider Electric L&T
50.	Selector Toggle Switch	Kaycee Salzer (Larsen & Toubro) ABB
51.	Sealed Maintenance Free Batteries	Amar Raja Exide Hitachi
52.	Battery Charger	Caldyne Chhabi Electricals

Sr. No.	Material/ Equipment	Vendor
		Amar Raja Hitachi
53.	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
54.	Fire Survival cables	INDIA-IMPEX(FRTEK) LEONI Bonton Fusion Polymer
55.	DG Set (Engine)	Caterpillar Cummins MTU Mitsubishi
56.	DG Set (Alternator)	Cummins(Stamford /AVK) Leroy Somer BHEL
57.	Anti Vibration Mountings	Gerb Resistoflex Kanwar
58.	Timers	Schneider Siemens L&T Legrand
59.	HSD – Storage Tank	Engineers Syndicate Multi Engineering Sermes Hydrotherm Engineering
60.	Flexible Coupling	Resistoflex Kanwal

Sr. No.	Material/ Equipment	Vendor
61.	Residential Silencer	Nelson Cummins Sterling Power Catter Pillar
62.	MS Pipes for Exhaust System	Jindal Hissar Tata SAIL
63.	MS Pipes/ GI pipes for fuel system	Jindal Hissar Tata SAIL
64.	Pressure/Temperature Gauges	H Guru Feibig Emerald
65.	Vibrator Eliminator	Kanwal Resistoflex Dunlop
66.	Semi Rotary type hand fuel filling pump	Rotodel Kitty Binks
67.	Polycarbonate Sockets	Clipsal MANNEKER Legrand
68.	Water Tight Polycarbonate Boxes	Hensel Legrand Phraser
69.	Astronomical Timer	The ben ABB

Sr. No.	Material/ Equipment	Vendor
		Siemens
70.	APFC / HPFC Capacitor Panels	Schneider EPCOS ABB
71.	Capacitor (APP) / Series reactors / APFC relay	Schneider EPCOS ABB L & T
72.	UPS	Emerson Schneider Eaton Socomec

Note:-

1) The Bidder shall offer the equipment of makes mentioned above. Other makes are subjected to Client approval before procurement.

2) The items manufactured in India shall be permitted only if the items are ISI marked (any other definition of compliance to BIS shall not be acceptable).

3) Samples from all the approved makes shall be offered for selection.

4) For standardization, inventory, electrical system coordination, the Employer/ Employer's Representative can insist on any one make from the makes indicated above.

5) The items shall meet specifications. Mere mention of a make as approved make in the above list does not qualify for acceptance of an item.

TECHNICAL SPECIFICATIONS FOR WATER SUPPLY, SANITARY & DRAINAGE WORKS

1.0 SCOPE

1. This specification covers the general requirements of providing and laying water mains and water supply piping, providing and fixing sanitary fixtures and piping and providing and laying drainage lines.

2. For specifications, mode of measurements and scope of work covered under the respective items for the work included under this contract, following documents shall be referred to in the order of precedence as given below:

   a) Description of the items and notes if any given in the Schedule of Quantities.
   b) Scope of work
   c) Drawings
   d) Specifications.
   e) Additional / Special Conditions of Contract.
   f) General Conditions of Contract.
   g) Applicable Codes and Standards as specified herein with amendments/ revisions issued till date.

   In the event of any discrepancy among the documents referred above, the document in the higher order of precedence shall prevail.

3. In the event of any element of the specification not being available in any of the documents mentioned above, the instructions of the Engineer-in-Charge in writing shall be followed by the Contractor.

4. The Work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Engineer-in-Charge duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer-in-Charge's signature and stamp. Similarly, the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer-in-Charge in writing.

5. The Work shall be executed and measured as per approved drawings and schedules.

6. The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilize them to the extent possible. In any case, the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful

7. The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as called for the different equipment.

8. Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

9. In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping system or

mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage is done, on account of Contractors carelessness, open or burst pipes or failure of fittings, during testing and commissioning to the building, furniture and fixtures shall be made good by the Contractor

2.0 GENERAL PROVISION

2.1 Scaffolding

2.1.1 Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS: 4014 and IS : 3696. An independent tied scaffold (double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board. Diagonal braces shall not prevent the material being moved along the scaffold run. The scaffolding shall be suitably packed at the ends to prevent damage to the finished work.

2.2 Protection

2.2.1 Protection against damage: Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.

2.2.2 Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.

2.2.3 During installation of piping, the open end of pipe shall be protected with temporary cover to prevent dust or other materials entering in it.

2.2.4 Protection during construction: Decorative surfaces shall be carefully protected during construction by a temporary cover.

2.2.5 Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.

2.2.6 Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.

2.2.7 Any disfigurement, discoloration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer-in-Charge, as to whether any work either in whole or in part is acceptable or not shall be final and binding on the Contractor.

2.3 Guarantee

The Contractor shall guarantee and undertake to maintain and rectify the various components of the Plumbing work installed by him for successful performance for a period as indicated in the Datasheet-A. The Contractor shall indemnify the Engineer-in-Charge for a similar period against any damage to property and injury to persons on account of

any defective work or maintenance carried out by the Contractor. The format and text of the Guarantee and the Indemnity Bond shall be given by the Engineer-in-Charge.

3.0 APPLICABLE CODES, STANDARDS, AND PUBLICATIONS

All equipment, supply, erection, testing, and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the contractor shall meet the requirements of IS, and other Codes/ Publications as given below.

SP:6(1)	Structural steel sections
IS:325	Three phase induction motors
IS:554	Dimensions for pipe threads where pressure-tight joints are required on the threads
IS:694	PVC insulated cables for working voltages up to and including 1100 V.
IS:771	Part I to Part VII-Specification for vitreous china sanitary ware
IS:778	Specification for gunmetal gate, globe and check valves for water, steam and oil only
IS:779	Specification for water meters (domestic type)
IS:783	Code of practice for laying of concrete pipes
IS:800	Code of Practice for general construction in steel
IS:1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium
IS:1172	Code of Basic requirements for water supply drainage and sanitation
IS:1367	(Part 1) Technical supply conditions for threaded steel fasteners: Part I Introduction and general information
IS:1367	(Part 2) Technical supply conditions for threaded steel fasteners: Part 2 Product grade sand tolerances.
IS:1554	PVC insulated (heavy duty) electric(Part 1) cables: Part 1 For working voltages up to and including 1100 V.
IS:1554 (Part 2)	PVC insulated (heavy duty) electric cables: Part 2 For working voltages from3.3 kV up to and including 11 kV.
IS:1703	Specification for ball valves (Horizontal plunger type) including floats for water supply purposes
IS:1711	Specification for self closing taps for water supply

IS:1726	Specification for cast iron manhole covers and frames
IS:1742	Code of practice for building drainage
IS:2064	Selection, installation, and maintenance of sanitary appliances - Code of practice
IS:2065	Code of practice for water supply in buildings
IS:2104	Specification for water meter boxes(domestic type)
IS:2373	Specification for water meters (bulk type)
IS:2379	Colour code for identification of pipelines.
IS:2527	Code of practice for fixing rainwater gutters and downpipes for roof drainage
IS:2548 (Part I & II)	Specification for plastic seats and covers for water closets
IS:2629	Recommended practice for hot-dip galvanizing on iron and steel
IS:2685	Code of practice for selection, installation and maintenance of sluice valves
IS:2692	Specification of ferrules for water services
IS:3114	Code of practice for laying of cast iron pipes
IS:4038	Specification for foot valves for water works purposes
IS:4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Part 1Manholes
IS:4127	Code of practice for laying glazed stoneware pipes
IS:4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes
IS:4985	Unplasticised PVC pipes for potable water supplies – specification.
IS:5329	Code of practice for sanitary pipework above ground for buildings
IS:5455	Cast iron steps for manholes
IS:6159	Recommended practice for design and fabrication of material prior to galvanizing
IS:7558	Code of practice for domestic hot water installations
IS:8321	Glossary of terms applicable to plumbing work
IS:9668	Maintenance of water supplies and firefighting.

IS:9842	Preformed fibrous pipe insulation
IS:9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipelines
IS:10221	Code of practice for coating and wrapping of underground mild steel pipelines
IS:10234	Recommendations for general pipeline welding
IS:10446	Glossary of terms relating to water supply and sanitation
IS:11149	Rubber Gaskets
IS:11790	Code of practice for preparation of butt welding ends for pipes, valves, flanges, and fittings
IS:12183 (Part 1)	Code of practice for plumbing in multi-storeyed buildings: Part 1 Water Supply
IS:12235 (Part 1 to 11)	Methods of test for unplasticized PVC pipes for portable water Supplies
IS:12251	Code of practice for drainage of building basements
IS:12701	Specification for rotational molded polyethylene water storage tanks
IS:13592	Specification for un plasticized PVC pipes for soil and waste discharge system inside building including ventilation and rainwater.
BS:5572	Code of practice for sanitary pipework
BS:6700	Specification for design, installation, testing, and maintenance of services supplying water for domestic use within buildings and their cartilages
BS:8301	Code of practice for building drainage
BSEN274	Sanitary tapware, waste fittings for basins, bidets, and baths. General technical specifications
IS:458	Specification for precast concrete pipes(with and without reinforcement)
IS:651	Salt-glazed stoneware pipes and fittings
IS: 1239 (Part 1)	Mild steel tubes, tubular and other wrought steel fittings: Part 1 Mild steel tubes
IS:1239	Mild steel tubes, tubular and other wrought steel fittings:

IS:1536	Centrifugally cast (spun) iron pressure pipes for water, gas, and sewage
IS:1538	Cast iron fittings for pressure pipes for water, gas, and sewage
IS:1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings, and accessories
IS:1879	Malleable cast iron pipe fittings
IS:1978	Line pipe
IS:1979	High test line pipe
IS:2501	Copper tubes for general engineering purposes
IS:2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions
IS: 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Part 2 Tolerances
IS:2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes
IS:3468	Pipe nuts
IS:3589	Seamless or electrically welded steel pipes for water, gas, and sewage(168.3mm to 2032mm outside diameter)
IS:3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS:4346	Specifications for washers for use with fittings for water services
IS:4711	Methods for sampling steel pipes, tubes, and fittings
IS:6392	Steel pipe flanges
IS:6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS:7181	Specification for horizontally cast iron double flanged pipes for water, gas, and sewage.
IS:778	Specification for copper alloy gate, globe and check valves for water works purposes
IS:780	Specification for sluice valves for water works purposes (50mm to 300mmsize)

IS:1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS:2906	Specification for sluice valves for water works purposes (350mm to 1200 mm size)
IS:3950	Specification for surface boxes for sluice valves
IS:5312 (Part 1)	Specification for swing check type reflux (nonreturn) valves: Part 1Single door pattern
IS:5312	Specification for swing check type reflux (non return) valves: Part 2 Multi door pattern
IS:12992	Safety relief valves, spring loaded: (Part 1) Part1Design
IS:13095	Butterfly valves for general purposes
IS:771(Part 1 to 3)	Specification for glazed fire-clay sanitary appliances
IS:774	Specification for flushing cistern for water closets and urinals (other than plastic cistern)
IS:775	Specification for cast iron brackets and supports for wash basins and sinks
IS:781	Specification for cast copper alloy screw down bib taps and stop valves for water services
IS:1700	Specification for drinking fountains
IS:2326	Specification for automatic flushing cisterns for
IS:2548 (Part 1)	Specification for plastic seats and covers for water closets: Part 1: Thermoset seats and covers
IS: 2548(Part 2)	Specification for plastic seats and covers for water closets: Part 2: Thermoplastic seats and covers
IS:2556(Part 1)	Specification for vitreous sanitary appliances (vitreous china): Part 1:General requirements
IS:2556(Part 2)	Specification for vitreous sanitary appliances (vitreous china) Part 2: Specific requirements of wash down water closets
IS:2556(Part 3)	Specification for vitreous sanitary appliances (vitreous china) Part 3: Specific requirements of squatting pans
IS:2556(Part 4)	Specification for vitreous sanitary appliances (vitreous china) Part 4: Specific requirements of wash basins

IS:2556 (Part 6 Sec 2)	Specification for vitreous sanitary appliances (vitreous china) Part 6: Specific requirements of urinals, Section 2 Half stall urinals
IS:2556 (Part 6 Sec 4)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 4 Partition slabs
IS:2556 (Part 6 Sec 5)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 5 waste fittings
IS:2556 (Part 6 Sec 6)	Specification for vitreous sanitary appliances (vitreous china) Part 6: Specific requirements of urinals, Section 6 Water spreaders for half stall urinals
IS:2556(Part 7)	Specification for vitreous sanitary appliances (vitreous china) Part 7: Specific requirements of half round channels
IS:2556(Part 8)	Specification for vitreous sanitary appliances (vitreous china) Part 8: Specific requirements of symphonic wash down water closets.
IS:2556(Part 11)	Specification for vitreous sanitary appliances (vitreous china) Part 11: Specific requirements for shower rose
IS: 2556(Part 12)	Specification for vitreous sanitary appliances (vitreous china) Part 12: Specific requirements of floor traps
IS:2556 (Part 15)	Specification for vitreous sanitary appliances (vitreous china) Part 15: Specific requirements of universal water closets
IS:2692	Specification for ferrule for water services
IS:2717	Glossary of terms relating to vitreous enamelware and ceramic metal systems
IS:2963	Specifications for copper alloy waste fittings for wash basins and sinks
IS:3311	Specification for waste plug and its accessories for sinks and wash basins.
IS:5961	Specification for cast iron gratings for drainage purposes.
IS:6249	Specification for flush valves and fittings for marine use
IS:6411	Specification for gel coated glass fibre reinforced polyester resin bathtubs
IS:8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services

IS:9758	Specification for flush valves and fitting for water closets and urinals.
Manual for Water Supply & Treatment	CPHEEO Manual for Water Supply & Treatment -1999- MoUD, GoI
SP 7 (Part-9 Section-1) 1983	National Building Code of India
SP 35:1987	Hand book on water supply & drainage
IS 1172 :1993	Code of Basic requirements for water supply, drainage and Sanitation
IS: 8329-2000	Centrifugally Cast (spun) ductile iron pressure pipes for water, gas and sewage
IS: 5382-1985	Specification for Rubber sealing rings for gas mains, water mains and sewers.
IS: 1500	Code for Hardness test for DI pipes
IS 11906:1986	Recommendations for cement mortar lining for cast iron, Mild steel and Ductile Iron pipes and fittings for transportation of water
IS 12288:1987	Code of practice for laying of ductile iron
IS 2373:1981	Water meter (bulk type)
IS 15778	Chlorinated PVC pipe

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

1. The Work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.

2. At the site level, the Contractor shall arrange the materials, their stacking/ storage in an appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies etc. as directed by the Engineer-in-Charge. The test shall be conducted continuously and the result of tests maintained. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

3. The Engineer-in-Charge shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

4. The test shall be conducted at the site laboratory that may be established by Engineer-in-Charge or at any other Standard Laboratory selected by Engineer-in-Charge.

5. The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer-in-Charge shall have them transported and recover two times the actual cost of the Contractor's bills.

6. Testing charges shall be borne by the Contractor.

7. Testing may be witnessed by the Contractor or his authorized representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

5.0 SANITARY WARE AND OTHER APPLIANCES

5.1 SCOPE OF WORK

5.1.1 Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following:-

- Sanitary appliances and fixtures for toilets
- Chromium plated brass fittings
- Stainless steel sinks
- Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.
- Mirrors, hand dryers, drinking water fountains, etc.

5.1.2 Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, washers, Teflon tape, sealant, cement, brackets, supports, paints, connectors, cp riser pipes, adapters, bolts, screws, hangers etc as required.

5.1.3 All exposed pipes within toilets and near appliances/ fixtures shall be of chromium plated brass or copper unless otherwise specified.

5.2 GENERAL REQUIREMENTS

5.2.1 All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer-in-Charge. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer-in-Charge.

5.2.2 All appliances, fixtures, and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, and drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, washers, screws and required connection pieces.

5.2.3 Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

5.2.4 Porcelain sanitary ware shall be glazed vitreous china of first quality free from warps, cracks and glazing defects conforming to IS: 2556. The choice of the colour of the Sanitaryware shall be that of the Engineer-in-Charge and nothing extra shall be payable to the Contractor for fixing of Sanitary ware of any colour.

5.2.5 Sinks for kitchen shall be of stainless steel or as specified in drawing.

5.2.6 Chromium plated fittings shall be cast brass chromium plated of the best quality approved by the Engineer-in-Charge.

5.2.7 If the supply of sanitary appliances, fixtures & fittings are in client's scope, no damages shall occur to the same during shifting, transportation, installation till successful handing over. If any damage occurs, the same shall be replaced by the contractor at his own cost.

5.2.8 All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown in the drawings and in accordance with the manufacturer recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost.

5.2.9 All materials shall be rustproofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

5.2.10 Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

a) Contractor shall, during the entire period of installation and afterward protect the appliances by providing suitable cover or any other protection in order to absolutely prevent any damage to the appliances until satisfactory handing over. (The original protective wrapping shall be left in position for as long as possible).

b) The appliance shall be placed in correct position or marked out in order that pipework can be fixed or partially fixed first.

c) The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

d) All appliances shall be securely fixed. Manufacturers' brackets and fixing methods shall be used wherever possible. Compatible rust proofed fixings shall be used. Fixing shall be done in a manner that minimizes noise transmission.

e) Appliances shall not be bedded (e.g. WC pans, pedestal units) in the thick strong mortar that could crack the unit (e.g. a ceramic unit).

f) Pipe connections shall be made with de-mountable unions. Pipework shall not be fixed in a manner that it supports or partially supports an appliance.

g) Appliances shall be fixed so that waterfalls to the outlet (e.g. baths).

h) All appliances shall be secured as per the recommendations of the manufacturer.

i) Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

5.2.11 Sizes of Sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of makes considered. Dimensions of similar models of other makes may vary within +/-10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

5.3 WATER CLOSET

5.3.1 WC shall be washed down or symphonic wash down type wall mounted set designed for low volume flushing from 3-6 litres of water, flushed by means of a flushing cistern or an exposed or concealed type (as detailed in the drawings, schedules or as directed by the Engineer-in-Charge) 32mm size CP brass flush valve with regulator valve. Flush pipe/ bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Engineer-in-Charge.

5.3.2 Each WC set shall be provided with a solid plastic seat, rubber buffers, and chromium-plated brass hinges. The plastic seat shall be so fixed that it remains absolutely stationary in a vertical position without falling down on the WC.

5.3.3 Each WC set shall be provided with a fixed type CP brass ablution jet if called for in schedule of quantities, complete with CP/ plastic piping, concealed type CP brass angle cock etc. all of approved make and brand. The nozzle of the ablution jet and its holding down plate shall have smooth and rounded edges and shall not be capable of causing any injury to a user or cleaner.

5.4 PAN CONNECTOR

5.4.1 The WC pan connector shall be Flexible, soft and shall be made of single body construction with integral fins, made from EVA (Ethyl Vinyl Acetate). The pan connector must conform to the BS: 5627: 1984. The pan connector must be supplied with factory fitted spring loaded seal guard.

5.4.2 The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.

5.4.3 The pan connectors must be stored away from the direct sunlight and flames.

5.4.4 While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush/adaptor shall be used. The connector socket is pushed fully home onto the pan spigot; thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such an easy as to ensure that the seals and fins turn inward to ensure proper sealing.

5.1 URINALS

5.1.1 Urinals shall be electronic sensor operated lipped type half stall white glazed vitreous china of size as paint of make, brand, and color as approved by the Engineer-in-Charge.

5.1.2 Half stall urinals shall be provided with 15mm diameter CP spreader, 32mm diameter CP domical waste and CP cast brass bottle/"P" trap with pipe and wall flange and shall be fixed to the wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Engineer-in-Charge.

5.1.3 Flushing for urinals shall be by means of no hand operation, PVC or ceramic flushing cistern / electronic auto flush valve with all internal fittings, mounted on a C.I. bracket, and painted with two coats of approved paint of approved shade and confirming to IS: 2326.

5.1.4 Flush pipes shall be PVC pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Schedule of Quantities. These shall be measured and paid for separately.

5.1.5 PVC waste pipes shall be provided for urinals. Waste pipes may be exposed on the wall or concealed in the chase as directed by the Engineer-in-Charge. These shall be measured and paid for separately.

5.2 URINAL PARTITIONS

5.2.1 Providing and laying Urinal Partition (400 mm x 1,200 mm) of machine cut and both side machine pre-polished Granite Stone slab, Type: W14, 19 mm thick of size as per drawings set on backing coat of cement mortar 1:3 not exceeding 19 mm thick, including pointing with matching cement paste with pigmented additives to match the shade of the slab

5.3 WASH BASIN

5.3.1 Wash basins shall be white glazed vitreous china of counter type (size630 mm x 450 mm) and electronic sensor operated of make, brand, and color as approved by the Engineer-in-Charge /Architect.

5.3.2 Each basin(where counter type not possible) shall be provided with painted MS angle or C.I. brackets and clips and the basin securely fixed to the wall. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand, and color as approved by the Engineer-in-Charge.

5.3.3 Each basin shall be provided with 32mm diameter CP waste with overflow, pop-up waste or rubber plug, CP angle valve, CP riser pipe with connectors/adaptors and CP brass

chain as specified in the Schedule of Quantities, 32mm diameter CP brass bottle trap with CP pipe to wall flange.

5.3.4 Wash basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

5.3.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 790mm from finished floor level or as directed by the Engineer-in-Charge.

5.3.6 All toilets to be completed in all respect including wc, wash basin(sensor operated), Urinal(sensor operated) and all other necessary arrangements like but not limited to taps, health faucet etc complete in all respect as per drawing , make and design as approved by the Engineer-in-Charge/Architect.

5.4 SINKS

5.4.1 Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.

5.4.2 Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Countertop sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm diameter CP waste, CP angle valve, CP riser pipe with connectors/adaptors and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand, and color as approved by the Engineer-in-Charge. Flow Rate = 4.5 to 6 Litres per minute @ 80 PSI

5.4.3 Supply fittings for sinks shall be deck mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. These shall be measured and paid for separately.

5.5 TOILETS FOR DIFFERENTLY ABLED

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by the Owner's Site Representative.

Stainless steel garb brass of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with chromium plated long handles.

5.6 FINAL INSTALLATION

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built-in piping system. All unions and flanges shall match in appearance with other exposed fittings.

6 SOIL, WASTE, VENT AND RAINWATER PIPES

6.1 SCOPE OF WORK

Soil, waste, vent, and rainwater disposal scope shall include Supply, Installation, testing, commissioning and successful handing over to the client as per the drawings, specifications, and schedule of quantities.

All soil, waste and storm water disposal for the portion above ground level to the public sewers shall be by gravity, whereas from the basements it shall be by pumping. Without restricting to the generality of the foregoing, the soil, waste, vent and rainwater pipes system shall inter-alia include the following:

a) Vertical and horizontal soil, waste, vent and rainwater pipes and fittings, joints, supports, paints, and connections to fixtures.

b) The connection of all pipes to sewer lines as shown in the drawings at ground level.

c) Floor and urinal traps, clean out plugs, inlet fittings, and rainwater (roof) outlets.

d) Testing of all pipes and fittings in the workshop.

e) Testing, commissioning and handing over of all pipes lines after installation.

6.2 GENERAL REQUIREMENTS

6.2.1 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.2.2 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

6.2.3 Pipes shall be securely fixed to walls, and ceilings with suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for fixing pipes on RCC ceilings and RCC/ masonry walls.

6.2.4 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

6.2.5 Long bends shall be used on all main pipelines as far as possible. Use of elbows shall be restricted for short connections.

6.2.6 Wherever piping is going across the separation/expansion joints of buildings, the piping shall be provided with flexible connectors on both sides of such joints or on the single side depending on whether any wall is to be crossed or not.

6.3 WASTE PIPE FROM APPLIANCES

6.3.1 Waste pipe from appliances e.g. washbasins, baths, sinks, and urinals etc. shall be of UPVC confirming IS 4985 as given in the Schedule of Quantities.

6.3.2 The internal diameter sizes of outlet branch waste pipes for different fittings shall be as follows:

Wash basin - 32 dia

Urinals - 50 dia

Sink - 50 dia

Nahani Trap - 75 diameter, 50 mm seal

Multi Floor Trap - 75 or 100 dia. as required, with 50 mm or 75 mm seal / bolted aluminium grating in 25×25 MS angle

P Trap - 75 mm water seal as required with bolted aluminum grating in 25×25 MS angle

6.3.3 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps as directed by the Engineer-in-Charge. Spacing for the clamps shall be 3000mm for vertical runs and 2400mm for horizontal runs.

6.3.4 Pipes shall be UPVC tubes conforming to IS: 4985 and quality certificates shall be furnished. Pipes shall be provided with all required fittings conforming to IS: 4985 e.g. tees couplings, bends, elbows, unions, reducers, nipples, plugs etc. All UPVC waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes shall be painted as specified in tender.

6.3.5 The pipes shall be of class III, 6 Kg/cm2. The pipes shall conform to IS 4985 - 2000. Fittings shall be of injection moulded PVC conforming to IS 7834 (Part1) - 1975.

6.3.6 Pipe sleeves and inserts, etc. through RCC wall of buildings either external or internal or for water tanks shall be of PVC provided with water bar flanged.

6.3.7 W.C. pan connectors shall suit the requirements as per drawing, with 40 dia. vent horn for connection to the anti-siphonage pipe. Pan connector shall be of C.I. or lead.

6.3.8 Connection to the sewer or stormwater collection sumps to be perfectly watertight and as specified in the drawing.

6.3.9 Rainwater flashing shall be of 150× 100 or 230× 150 fitted on to the bell mouth of rainwater pipes inlet and then covered with cast iron grating and extension piece.

6.3.10 All rainwater pipes and fittings shall be soil type variety conforming to I.S. 1729-1964 or equivalent. This shall apply to pipe outside buildings within the building or in separate shafts.

6.3.11 Bathroom C.P. grating shall be having bolted down design out of heavy cast brass with chromium plating of the best-approved standards.

6.3.12 Cast iron grating shall be flat with a perfect edge and of the best quality procurable of the specified width and thickness and in the available length.

6.4 PIPE LAYING AND FIXING

The pipe laying and jointing shall be done in accordance with IS 7634 (Part 3) – 1975. Pipes shall be cut to size and chamfered well. Burr's if any shall be removed. Pipes and fittings shall be joined using solvent cement or rubber ring joints. The pipes and fittings shall be jointed accurately without any stress to achieve leak proof joints.

6.5 TESTING

The method which is commonly in use is filling the pipe with water, taking care to evacuate any entrapped air and slowly raising the system to the test pressure at 3Kg/cm2. The pressure testing may be followed as follows. The field test pressure to be imposed should be not less than the greatest of the following:

- One and half times of maximum sustained operating pressure.
- One and half times the maximum pipeline static pressure.
- Sum of the maximum sustained operating pressure and the maximum surge pressure.
- Sum of the maximum pipeline static pressure and the maximum surge pressure, subject to a maximum equal to the works test pressure for any pipe fittings incorporated.

- The field test pressure should wherever possible be not less than 2/3rd working pressure and should be applied and maintained for at least four hours. If the visual inspection satisfies that there is no leakage the test can be passed.

- A test register shall be maintained and all entries signed and dated by Contractor and Engineer-in-Charge. A Performa of the proposed test register shall be submitted to the Engineer-in-Charge for approval.

- All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

6.6 CUTING AND MAKING GOOD HOLES / CHASES

Pipes shall be fixed and tested as the building work proceeds. Contractor shall provide all necessary holes, cut outs and chases in structural members as the building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:1:2 (1 cement: 1coarse sand :2 stone aggregate 20mm nominal size) or cement mortar 1:2 (1 cement :2 coarse sand) as directed by the Engineer-in-Charge and the surface restored as in original condition to the entire satisfaction of the Engineer-in-Charge at no extra cost.

6.7 DRAINAGE ACCESSORIES

a) Floor Trap / Urinal Trap Grating

Floor/ urinal traps grating shall be of stainless steel square / round of size 125 x 125 mm square/round as approved by client & shown in the drawing. Floor trap assembly shall be provided with round stainless steel strainer basket as a cockroach trap. Entire assembly shall be complete with ring, frame, outer cup, inner cup, grating, screws etc. of an approved make.

b) Floor Cleanout

Floor cleanout cover shall be of stainless steel square / round of size 125 x 125 mm square/round as approved by client & shown in the drawing. Floor cleanout assembly shall be complete with ring, outer frame, cover, screws etc. of an approved make.

c) Ceiling Cleanout

Ceiling cleanout cover shall be in nickel bronze / PVC plug type / GI flanged type of round shape matching pipe size as approved by client & shown in the drawing. Ceiling cleanout assembly shall be threaded with key hole for opening / flanged type suitable for pipe. Threaded cover shall be used up to 100 mm size & above shall be GI flanged type with GI nuts & bolts. PVC cover shall be used for PVC drainage piping only, whereas nickel bronze & GI flanged type cover shall be used for HDPE / CI / CI LA pipe work.

d) Cockroach Traps

Floor/ urinal traps shall sealed cover provided with 100-150mm square or round stainless steel cockroach trap assembly complete with ring, outer cup, inner cup, jali etc. of an approved make.

e) Wire Balloons / Grating For Rain Water Pipes

The wire balloons and the domical gratings shall conform to IS: 1729. The wire balloons shall be of galvanised steel. The CI domical gratings for the roof outlet shall be minimum 13mm thick.

Leaf and Gravel grates along with a perforated ring shall be made out of M.S. flat/bars of a design and dimension as shown in the drawing or as directed by the Engineer-in-Charge. These shall be painted with epoxy paint with a DFT of 200 microns.

Wire balloons/gratings for rainwater pipes shall be measured by numbers for different sizes. Leaf and gravel grates along with the perforated ring shall be measured in kgs.

6.8 RAINWATER PIPES

All rainwater pipes shall be of UPVC as shown in drawing & specified in specification. UPVC piping shall conform to IS: 13592 g or as specified in the schedule of quantities.

6.9 RAIN WATER OUTLET

a) Rain water out shall be preferably scupper type drain with cast iron body & cast aluminium grating with stainless steel screws. Suitable adopter / connector shall be used to match the pipe. Wherever shafts are not available near rain water outlet, dome type rain water outlet shall be installed.

b) Rain water outlet shall be tested for water leaking, prior to waterproofing treatment. Extreme care shall be taken, while sealing gap between rain water outlet & wall / slab.

6.10 CLAMPS

Wherever MS/GI clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement:2 sand:4stone aggregate 20mm nominal size) as directed by the Engineer-in-Charge.

6.11 ANGELS / CHANNELS

Slotted angles/ channels shall be measured per linear metre of finished length and shall include support bolts and nuts, length embedded in the cement concrete blocks of 1:2:4 (1cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) formed in the masonry walls; nothing extra shall be paid for the cement concrete block and making good the masonry wall, anchor fasteners etc. complete.

6.12 INSTALLATION OF SOIL, WASTE & VENT PIPES

All Horizontal pipes running below the slab and along the ceiling shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall

be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

Before joining, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The joint shall not be covered till the pipeline has been tested under pressure. Rest of pipeline shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

All open terraces shall be drained by rainwater down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge to rainwater harvesting tank and excess rainwater will be diverted to the external stormwater drain.

7 WATER SUPPLY SYSTEM

7.1 SCOPE OF WORK

The scope shall include supply, installation, testing, commissioning and satisfactory handing over of the complete water supply system to client as per drawings, specifications and schedule of quantities. The water supply system shall inter-alia include the following:

a) Distribution system from main supply or overhead tank to all fixtures and appliances for cold water.

b) Pipe protection and painting.

c) Control valves, masonry chambers and other appurtenances.

d) Connections to all plumbing fixtures, tanks, appliances and municipal mains

e) Inserts, nozzles for R.C.C. tanks

The term water supply is used as indicative of all water supply work required and necessary for the building including such external work as may be necessary to make the system functional.

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

a. Tapping from available main sourcel /Tanker water supply/

b. Domestic water supply.

c. Flushing water supply

The contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the owner.

7.2 GENERAL REQUIREMENTS

7.2.1 If necessary and if approved by the Engineer-in-Charge, where unavoidable, bends may be formed by means of a hydraulic pipe bending machine for pipes up to 20mm dia. No bending shall be done for pipes of 25mm diameter and above. After bending zinc rich paint shall be applied wherever the zinc coating is damaged.

7.2.2 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs. Valves shall be located at a height not exceeding 1.6m above their operating floor/ platform level. Where such a provision is not possible and the valve is to be frequently operated a MS chain shall be provided for its operation.

7.3 CPVC PIPE

Supplying, Installing, Testing and Commissioning of exposed and concealed Cold & Hot water Chlorinated Polyvinyl Chloride (CPVC) pipework. Pipes shall confirm as per ASTM D 2846, SDR 11 up to 50 mm diameter and ASTM F441, Schedule 40 pipe for above 50 mm diameter. Fittings shall be as per ASTM F438, Schedule 40 for pipe up to 50 mm diameter and ASTM F439, Schedule 40 for pipe above 50 mm diameter. The fittings and specials such as tees, elbows, couplers, bends, enlargers, flanges, unions connectors, adapters etc. with CPVC brass threaded combination/ transition specials such as male adapters, brass threaded female adapters, brass FPT Tee, Brass FPT elbow, etc. where connection with metal is to be made including necessary drilling holes, chasing walls and making the same good in cement mortar 1:1, restore the same to original condition neatly as directed by the Engineer. Joints to be made with CPVC solvent cement shall be as per ASTM F493. Manufacturer's recommendation shall be followed for installation of pipe & jointing of CPVC pipework

7.4 GI PIPES, FITTINGS AND VALVES

7.4.1 All pipes inside the buildings and where specified, outside the building shall be M.S. galvanized steel tubes conforming to IS: 1239 of Class specified.

When Class is not specified they shall be Heavy Class. All embedded / concealed pipes shall be of heavy duty.

7.4.2 Fittings shall be of malleable cast iron galvanized, of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for GI pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes etc. Fittings etc. shall conform to IS: 1879.

7.4.3 Pipes and fittings shall be jointed with screwed joints using Teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively. GI pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings. All pipe joints after testing of the line shall be seal welded and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

7.4.4 Bib cocks and stop cocks

All bib cocks and stop cocks shall be of C.P. brass conforming to IS: 781 of tested quality and approved make and design, of diameter as specified in schedule of quantities.

7.4.5 Clamps

GI pipes in shafts and other locations shall be supported by GI clamps of design approved by the Engineer-in-Charge. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from MS structures as described tender. Pipes in shafts shall be supported on slotted angles/ channels as specified/ as directed.

7.4.6 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock or check valve and on straight runs as necessary at appropriate locations as required for easy dismantling and/ or as directed by the Engineer-in-Charge.

7.4.7 Flanges

Flanged connections shall be provided on pipes as required for maintenance/ ease in dismantling or where shown on the drawings, all equipment connections as necessary and required or as directed by the Engineer-in-Charge. Connections shall be made by the correct number and size of the GI nuts/ bolts as per relevant IS Standards and made with 3mm thick insertion rubber washer/gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by the Engineer-in-Charge. Bolt hole dia for flanges shall conform to match the specification for CI sluice valve as per IS: 780. Gaskets shall conform to IS: 11149.

7.4.8 Trenches

All GI/PVC/HDPE pipes running below ground shall have minimum cover of 600mm.

7.4.9 Excavation to be taken to proper depth

Excavation shall be done in all conditions of soil and to such a depth that the sewers / or other pipes shall rest as described in the several clauses relating thereto and so that the inverts may be at the levels given on the section. Should the contractor excavate the trench to a greater depth than is required the extra depth shall have to be filled up with concrete at the contractor's own cost to the requirements and satisfaction of the client / consultants.

7.4.10 Back filling (IS: 12288 – 19S87)

After the sewer or other piping work has been laid and proved to be water-tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this so that no damage is caused to the sewer and other permanent works.

7.4.11 Painting

a) All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality to give an even shade, or as specified by the Engineer-in-Charge.

b) Hot water pipes in the chase:

All hot water pipes fixed in wall chase shall be properly insulated by elastomeric tape as per manufacturer's recommendation.

7.4.12 Pipe protection

Where specified, pipes below the floor or below ground shall be protected against corrosion by the application of two or more coats of solvent-based rubberized asphaltic primer to give a uniform coat covered with 'Pipe coat Hiper', a puncture resistant non woven polyester mat. The application of pipe coat primer and "Hiper" membrane shall be as specified by the manufacturer.

7.5 VALVES & FITTINGS

7.5.1 Sluice Valves

Sluice valve shall conform to IS 14846-2000 relevant internationally recognized standards.

They shall be of non-rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.

The gate face rings shall be securely pegged over the full circumference.

Valve of 450mm and above shall be provided with thrust bearing arrangement for ease of operation.

Valve of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400N.

All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Specification for Sluice Valve

Standard:		IS -14846:2000
Ends:		Flanged and drilled as per IS-1538
Material of Construction		
(A)	Body:	Grey CI, IS-210, FG 260
(B)	Bonnet:	Grey CI, IS-210, FG 260
(C)	Non rising Stem:	High tensile brass, IS 320 / 6912, Gr.HTB-2 / FHTB-2 or Stainless Steel, IS 6603, Gr.12Cr1304Cr 18Ni10 04Cr17Ni.12 MO2
(D)	Wedge:	Grey CI, IS 210, FG 260
(E)	Stem Nut:	Leaded tin Bronze, IS: 318,Gr.LTB-2
(F)	Body seat ring, wedge face ::	Leaded tin Bronze, IS: 318,Gr.LTB-2 ring & bushes.
(G)	Gland packing:	Jute & Hemp, IS: 5414
(H)	Hand Wheel:	Grey CI , IS-210, Gr. FG-260
(I)	Nuts:	Carbon steel, IS–1363(Part-3),Class 4.0
(J)	Bolts::	Carbon steel ,IS-1363 (Part-3),Class 4.6
(K)	Bonnet Gasket:	Rubber, IS-638, Type -B

Hydro test Pressure as per IS-14846:2000

Rating	Test for	Test Pressure
PN 1.0	Body	15 kg / cm² (1.5 MPa)
	Seat	10 kg / cm² (1.0 MPa)
PN 1.6	Body	24 kg / cm² (2.4 MPa)
	Seat	16 kg / cm² (1.6 MPa)

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7.5.2 Butterfly Valves

Resilient seated butterfly valve shall be as per IS 13095-1991/ BS 5155. Valve shall be suitable for mounting in any position.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels. Specification & M.O.C. of Butterfly valve :

General

a	Type	Both end flanged hand wheel / Gear operated
b	Rating of valves	PN 1.6
c	Manu. Standard	IS-13095:1991 / BS 5155
d	Sizes and quantity	As per Price schedule

Material of construction

a	Internal Hardware	S.S. AISI-304
b	Body./ Disc	CI. IS 210 FG260
c	Body ring(Retainer/seat)	Stainless steel ; AISI -304
d	Shaft Stainless steel;	AISI-410
e	Disc seat	EPDM rubber/ Nitrile rubber
f	Bush & Thrust Pad	G.M. IS :318 LTB-2 / Teflon
g	Body seat	S.S. AISI-304.

7.5.3 Non-Return Valve

The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.

Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

Dual plate check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The spring action shall optimize the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.

In case of the nozzle check valve, the disc shall be correctly positioned at all times to achieve fully non-slam closure. The spring shall be fully shielded from the flow stream by the central flow diffuser.

Tilting disc non-return valve shall incorporate a double offset shaft with a variable angle tilt disc configuration. Sealing shall be metal to metal. The disc shall be stable and shall not vibrate under full or partial load conditions.

Valve of diameter greater than 450 mm shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

Specification for Reflux Valve (Non Return Valve)

Standard	IS-5312(Part – I):2004 with latest edition
Ends	Flanged flat face and drilled in accordance IS.
Type	Swing type

Materials of Construction for Reflux Valve (Non Return Valve)

(A)	Body, cover, door, bearing holder	Grey CI, IS-210, FG 260
(B)	Hinge pin, door pin & door Suspension pin	S.S., IS-6603, 12Cr12
(C)	Body seat rings	Leaded Tin Bronze, IS-318, Gr.LTB-2
(D)	Door face ring:	Leaded Tin Bronze, IS-318, Gr.LTB-2
(E)	Bearing bushes/ Bearing block	Leaded Tin Bronze, IS-318, Gr.LTB-2
(F)	Plugs for hinge pin / Air release Plug	Leaded Tin Bronze, IS-318, Gr.LTB-2
(G)	Nuts	Carbon steel, IS-1363(Part-3),Class4.0 (H)
	Bolts	Carbon steel, IS-1363(Part-3),Class 4.6
(I)	Gasket	Rubber, IS : 638, Type –B

Hydro test Pressure as per IS-5312(Part – I):2000

Rating	**Test for**	**Test Pressure**

PN 1.0	Body	15 kg / cm² (1.5 MPa)
	Seat	10 kg / cm² (1.0 MPa)
PN 1.6	Body	24 kg / cm² (2.4 MPa)
	Seat	16 kg / cm² (1.6 MPa)

Materials of Construction for DPCV

Sr. No.	**Component**	**Material**
(a)	Body Cast Iron :	IS 210 Gr. FG 260
(b)	Disc	Aluminum Bronze
(c)	Stop & hinge pin	SS AISI-410
(d)	Seat ring (Disc)	EPDM Rubber
(e)	Bearings (Body& Plate lug)	PTFE
(f)	Body Seat	SS AISI-410
(g)	Spring	Spring steel

7.5.4 Forged Brass Ball Valve

(a) Valves of size 50 mm Dia. and below shall be full bore quarter turn lever operated female threaded forged brass hard chrome plated ball valves conforming to IS: 554. Valve shall have PTFE body seat rings and gland packing, forged brass ball, stem and bonnet, carbon steel nut washer and lever and finished in chrome. Valves shall have the minimum working pressure of 16 bars. Valves shall be tested at manufacturer's works and the same stamped on it.

7.5.5 Air Release Valve (AV)

Tamper Proof Air Valves shall be cast iron body, cover and cowl. Temper Proof Air valve working temperature shall be upto 50° C.

Hydrulic Test Pressure shall be as mentioned below.

Sr. No.	**Rating**	**PN 1.0**	**PN 1.6**	**Duration**
1	Body Test	15 Kg/Sq.cm.	24 Kg/Sqq.cm.	5 Min
2	Seat Test	10 Kg/Sq.cm.	16 Kg/Sqq.cm.	2 Min

Techanical Particulars of Temper Proof Air Valve

Sr. No.	Description	Particulars
	GENERAL	
1	Design and Manufacturing Code	AWWA C512
2	Size \Qty\Pressure Rating (PN)	As per Price Bid
3	Ends	Flanged
4	Type	Temper Proof
	MATERIAL OF CONSTRUCTION (M.O.C)	
1.	Body	Cast Iron
2.	Float	Stainless Steel
3.	Cover	Cast Iron
4.	Seat	Nitrile Rubber
5.	Nozzle	Bronze
6.	Bolts and Nuts	Carbon Steel
7.	Gasket	EPDM

7.5.6 Ball float valve

Ball valves with Heavy duty float to be fixed in storage tanks as shown in the drawing and shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system.

7.5.7 TESTING

(a) All pipes, fittings, and valves shall be tested in accordance with IS: 2065 except as may be modified hereinunder. All pipes, fittings, and valves, after fixing at the site, shall be tested to a hydrostatic pressure of 10 kg/cm2 or 1.5 times the shut-off head of the pump whichever is greater.

(b) The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

(c) A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer.

(d) After commissioning of the Water Supply System, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.

(e) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

7.6 PRESSURE REDUCING VALVE SET

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on the inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self-aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set downstream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of a replaceable porous sintered metal type.

(a) Pressure reducing valves are used to lower pipeline pressure to a predetermined set point. Pressure reducing valves protect installations against excessive pressure from the supply.

(b) Pressure reducing valves automatically controls downstream pressure, from no flow to full open flow, without regard to changes in inlet pressure. Outlet pressure control is smooth and precise since the friction and hysteresis of the valve and pilot are negligible.

(c) Because the valve will not chatter or slam under low flow conditions, it is not necessary to parallel pressure reducing valves with a second smaller size control valve to obtain accurate pressure control at low flow rates. In any size, pressure reducing valves will control pressure right down to shut off.

(d) Spring loaded pressure reducing valves operate by means of a force equalizing system. The force of a diaphragm operates against the force of an adjustment spring. If the outlet pressure and therefore diaphragm force fall because water is drawn, the then greater force of the spring causes the valve to open. The outlet pressure then increases until the forces between the diaphragm and the spring are

equal again. The inlet pressure has no influence in either opening or closing of the valve. Because of this, inlet pressure fluctuation does not influence the outlet pressure, thus providing inlet pressure balancing.

7.7 PRESSURE RELIEF VALVES

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve. PRV shall be of Brass.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

7.8 LEVEL CONTROLLED SOLENOID VALVES

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports.

Level sensor based solenoid valve will be installed at terrace level for automatic operation of the water transfer pump set.

7.9 UNDERGROUND / OVERHEAD STORAGE TANKS

7.9.1 Storage tanks for water supply shall be in RCC.

7.9.2 Each tank shall be provided with lockable type manhole cover fabricated from MS sheet or standard cast iron tank covers. Manhole covers shall be of an appropriate size as directed by the Engineer-in-Charge.

7.9.3 Each storage tank shall be provided with high and low-level annunciation by means of magnetic level switches.

7.9.4 One solid state electronic annunciation panel fully wired with a visual display and audible alarm unit shall be provided to indicate the following:

- High and low-level alarms for each water storage tank.
- On/ off status of all Pump sets namely domestic

7.9.5 All the necessary arrangements for fixing the panel shall be provided by the Contractor.

7.9.6 All the cabling from the respective level switches to the Annunciation Panel, MCC Switchgear to Annunciation Panel, including power supply from MCC shall be provided by the Contractor.

7.9.7 The number of outgoing terminals shall be equal to the number of incoming terminals from field/ MCC with 20% margin, so that necessary interconnection to BMS could be done at a later date.

7.10 TESTING

7.10.1 All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 10 kg/cm^2 or 1.5 times the shut off head of the pump whichever is greater.

7.10.2 The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

7.10.3 A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.

7.10.4 After commissioning of the water supply system, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.

7.10.5 All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

7.11 INSULATION

7.11.1 All open hot water flow and return pipes shall be insulated with preformed fibrous pipe sections conforming to IS: 9842.

7.11.2 Insulation to pipes shall be with pre-moulded pipe sections, the thickness for sections shall be:

a) Pipe 50mm diameter and below - 25mm thick

b) Pipe 65mm diameter and above - 40mm thick

7.11.3 Application:

a) All surfaces shall be thoroughly cleaned with a wire brush.

b) One layer of approved primer shall be applied and pre-moulded pipe insulation sections shall be fixed.

c) One layer of aluminum foil of thickness 0.711mm (20 SWG), shall be applied as a finish layer.

7.11.4 Insulation for hot water pipes in the chase:

All hot water pipes in chase shall be insulated with 3 mm elastomeric tape as per manufacturer's recommendations.

7.12 CONNECTION TO RCC WATER TANKS (PUDDLE FLANGE)

The contractor shall provide all inlets, outlets, washouts, vents, ballcocks, overflows control valves and all such other piping connections including a level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of an approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating with the bronze screen on vent.

The overflow pipe shall be so placed to allow the discharge of water is readily seen. The overflow pipe shall be of a size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

The floor and the walls of the tank shall be tiled with glazed tiles up to the overflow level. Alternatively, food grade epoxy to be applied.

7.13 WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS: 779 and IS: 2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

(Note: The water meters to be installed at every use of water such as Landscape irrigation, Domestic, Flushing, Firefighting etc.)

7.14 LEVEL SENSORS

Level sensor shall consist of the control unit, preamplifier and one full insulated probe-mounted vertically or two-part insulated probe mounted from tanks side wall adjustable switching system for pump control application, the same to be housed in stove enamel painted cast aluminium weatherproof suitable for black panel/wall mounting etc.,

The enclosure of probes shall be manufactured with the SS316 material. The least count of the central unit with amplifier should be +/- 0.10mm for response value of 30 seconds.

7.15 LEVEL INDICATORS

A level control system with electronic level probes is mounted on the face of the reservoir. The top two level sensors provide the ON-OFF signal for the treated water transfer pumps. A third level sensor enunciates a low-level alarm condition to the paging system and a fourth sensor enunciates an alarm to the paging system and stops the domestic water pumps from operating.

7.16 INSULATION

The insulation for hot water pipes shall be done as specified in Bill of Quantities and accordingly following guidelines shall be followed:

7.17 PAINTING / PIPE PROTECTION / INSULATION

Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear meter along the center line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

7.18 AIR RELEASE VALVES

Air release valve shall be installed as per specifications provided in BOQ.

Table Commonly Adopted Size of Air Valves

Size of Main mm	Type of Valve	Size of Air Valve mm
80	Single air valve	20
100	Double air valve	40
125-200	Double air valve	50
250-350	Double air valve	80
400-500	Double air valve	100
600-900	Double air valve	150
1000-1200	Double air valve	200

a) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

b) Each air release valve shall be provided with a cast iron isolating sluice valve specification given above.

7.19 MEASUREMENT AND RATES

Not Used

7.20 PUMPS FOR WATER SUPPLY & STROM DRAINAGE SYSTEM

(a) Hydro-pneumatic Pumps for domestic and flushing water supply (transfer pumps)

Pumps shall be vertical, centrifugal, multistage directly coupled to the motor. Provision of the pump with pump head & base of cast iron, Shaft of SS-316 and other parts in SS 304 shall be made for pumps required in Hydropneumatics System. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include the cost of foundation channel complete.

The Contractor shall supply and install pumps of the type and performance as shown in the drawings. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and will be interchangeable.

Leakage from pump gland shall be drained to the nearest floor waste.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction, concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.

(b) Vertical Multi-Stage Pumps

Multi-stage pumps shall be of a centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft.

Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with rigid universal couplings.

The shafts shall be stainless steel. Stainless steel diffuser shall be provided to protect the shaft in the water space and through the mechanical sealing.

The bearings shall be of the ball or roller type protected against ingress of water, dirt and other matter.

Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.

The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal. Pump motors above 7.5 KW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class “F” insulation and IP55 rating and shall be provided with built-in thermostats for protection against overheating.

. The hydropneumatics pumping units shall have the following features;

System Description

The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and flow sensor levels at the suction tank.

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.

The system shall be under the control of PLC.

A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via a control circuit.

(c) Vertical Submersible Pumps

Pump

a) The pump shall conform to IS 8034: 2000 amended up to date.

b) The pump shall be submersible bore well type directly coupled to submersible electric motor with built in anti-thrust bearing. The pump set shall be complete with suction strainer, anti-thrust streamlined non return valve and submersible type copper conductor cable of suitable size.

c) Inlet passage of the suction casing shall be designed reduce entry losses and strainer shall be provided in suction casing to restrain large solids entering the pump. For submersible type cables, clamping arrangement and cable guard shall be provided on pump casing.

d) Each metallic impeller shall be dynamically balanced to Grade G 6.3 of IS 11723.

e) The pump characteristic shall be non overloading type to ensure trouble free operation in the entire operating range.

Electric Motor

a) The submersible motor shall conform to IS 9283. The electric motor shall be three phase squirrel cage, water filled submersible type.

b) The motor shall be suitable for operation on 415V (3 phase), 50 Hz electric supply with required RPM capable of delivering the rated output with

i) The terminal voltage differing from its rated value by not more than +6% and -15%

ii) The frequency differing from its rated value by not more than 3% or

iii) Any combination of b) and ii).

c) Motor shall be capable of running continuously at a B. H. P. (brake horse power) not less than 10% in excess of that absorbed by pump set under any operating conditions.

d) Starting current for the motor shall be limited to 6 times the full load current.

e) Motor shall have minimum starting torque of 140% FLT and maximum starting torque 200% FLT. It shall have 100% FLT during running condition.

f) Contractor shall submit the motor details including manufacturer's guarantee for efficiency and P.F. at full load, no load, 3/4 load, 1/2 load.

Material of Construction

The material of construction shall be suitable for application and site conditions. The material of construction shall be as follows:

Sr.	Component	Material of Construction
1.	Pump bowl	High graded CI
2.	Impeller	Bronze Gr LTB2 / 20% Glass filled Noryl
3.	Diffuser	20% Glass filled Noryl
4.	Stage casing	High graded CI

Sr.	Component	Material of Construction
5.	Motor casing	SS 304
6.	Pump shaft	SS 410
7.	Motor shaft	SS 410
8.	Bearing bush	Bronze IS 318 Gr LTB 2,3,4,5
9.	Base	Cast iron / Brass
10.	Fasteners	SS 304
	Strainers	SS 304

Testing

Each pump-motor set shall be factory tested at manufacturer's works as per I.S. 8034 to determine following characteristics covering the full operating range.

-Head- Discharge curve

-Efficiency curve

-Dynamic balancing of rotor, impeller

Certificates

Contractor shall furnish:

- Performance characteristic curves.
- Catalogue of pump set and details of pump and its motor.
- Manufacturing test certificate, Guarantee card and list of parts for the pump sets.
- Operation and maintenance manuals for the pump set.
- Drawings showing cross sections of pumps, mounting arrangements, list of materials and necessary curves along with their offer.
- In the event of any pump failing to meet the specified requirement of pump set it shall be modified and retested until the requirements are fulfilled. The inspections and testing of the pump set are at contractors cost.

Makes

- Kirloskar, Willo Mather & Platt, Grundfos, Crompton & Greaves or any other equivalent approved by employer.

8.0 DI PIPES AND SPECIALS

The pipes shall be of centrifugally cast (spun) Ductile Iron pipes K-7 & K-9 class with internal cement motor lining confirming to IS 8329: 2000. The pipes shall be of push on joint type (Rubber Gasket Joints). The flange connection shall be used only in case of fitting of specials or under special circumstances as directed by Engineer in Charge.

The pipes shall be coated with zinc coating and finishing layer shall be of bitumen and have factory provided internal cement mortar lining as per the provisions of IS 8329: 2000 the mortar thickness shall be minimum 5 mm as per Table 15 of the code. The tolerances for pipes and fittings regarding dimensions, mass, ovality and deviations from straight line in case of pipes shall be as per IS 8329/IS 9523.

The pipes shall be supplied in standard length of 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety shall also be supplied with a rubber EPDM/ (SBR) gasket. The flanged joints shall confirm to Clause 6.2 of IS: 8329.The pipe supply shall include one rubber gaskets for each flange. Any change in the stipulated lengths will be approved by the Engineer- in -Charge. The gaskets shall conform to IS 5382:1985. The gaskets shall also be supplied by the contractor. They shall preferably be manufactured by the manufacturer of the pipes. In case they are not, it shall be the responsibility of the contractor to have them manufactured from a suitable manufacturer under his own supervision and have it tested at his / sub-contractors premises as per the instruction and to the satisfaction of the Engineer- in -Charge. The pipe contractor shall however be responsible for the compatibility and quality of the products. The flanged joints shall conform to Clause 6.2 of IS 8329.

Inspection and Testing of pipes during manufacture

Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS: 8329 / IS: 9523. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS: 8329. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/IS: 9523.

Brinell Hardness Test

For checking the Brinell hardness, the pipes used for the ring test and tensile test shall comply with the requirements specified in IS: 1500/IS: 8329.

Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS: 8329 / IS: 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with a 700 g hammer for confirmation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

The pipes shall be subjected to following tests for acceptance:

- Visual and dimensional check as per Clause 13 and 15 of IS 8329
- Mechanical Test as per Clause 10 of IS 8329
- Hydrostatic Test as per Clause 11 of IS 8329
- The test report for the rubber gaskets shall be as per acceptance tests of IS 5832 and will be in accordance to Clause 3.8. The sampling shall be as per the provisions of the IS 8329.

Markings

All pipes will be marked as per Clause 18 of IS 8329 along with the requisite information as provided below:

Manufacturer name / stamp

Nominal diameter

Class reference

A white ring line showing length of insertion at spigot end

Employers mark as “” “IITGNL"

Coatings

Pipe shall be supplied internally (cement mortar lining) and externally with Zinc coating along with a finishing layer of bituminous coating as per IS 8329:2000. The materials and finishing shall be as per the relevant specifications.

Joints

General

Jointing of DI pipes and fittings shall be done as per IS 12288 and manufacturer’s recommendations. Rubber sealing rings/gaskets used for jointing shall conform to IS 638, IS 12820 and IS 5382.

Spigot and Socket joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS 12820. The gaskets/sealant used for joints shall be suitable for water conveyance. The material of rubber gaskets for use with mechanical joints and push-on-joints shall conform to IS: 5382.

Flanged Joints

These shall be of 10 bar rating and shall comply with dimensions and drilling details as specified in IS 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. The bolts shall be of mild steel unless otherwise specified. They shall be coated with coal tar epoxy coating after tightening.

Slip on Type Couplings

Slip-on type couplings shall include the following couplings:

straight flexible couplings

stepped flexible couplings

Slip-on type couplings shall be procured from approved suppliers whose fittings meet the same Specification. The preparation of pipe ends for slip-on type couplings shall be in accordance with the requirements and the tolerances specified by the joint manufacturer. Couplings shall be installed fully in accordance with the manufacturer's recommendations.

Slip-on type couplings shall be protected if buried with Densomastic and Densotape wrapping or similar approved material applied in accordance with the manufacturer's recommendations. Flexible joints shall be harnessed or tied where shown on the Drawings. Flexible couplings shall be supplied with transit protection.

Specials and fittings

All DI specials and fittings shall be manufactured and tested in accordance with IS: 9523 or BS: 4772. All DI fittings shall be supplied with one rubber ring gasket for each socket. The rubber ring shall conform to IS: 12820 and IS: 5382. Flanged fittings shall be supplied with one rubber gasket per flange along with the required number of nuts and bolts.

Lubricant for Pipes and specials

Lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-on rubber ring joints shall confirm to IS 9523.

DI Pipe handling, Laying, jointing, testing and commissioning

- Laying of DI pipes shall conform to IS: 12288. All pipes, fittings and material shall be tested and approved by the Engineer- in -Charge before being laid. Polyethylene sleeves wound pipes shall be used for water logged areas as directed by the Engineer- in -Charge.
- The transportation and handling of pipes shall be made as per IS 12288.
- Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used. When using crane hooks at sockets and spigot ends; hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying according to the instructions of the pipe manufacturer. the trench must not be refilled before laying of the pipes
- All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. No pipe shall be laid in wet trench conditions. On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe laid does not move into or out of the socket of the laid pipe during the jointing operations. The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

- Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline. The assembly of the pipes shall be made as recommended by the pipe manufacturer using suitable tools.

Pipe testing and commissioning

The pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber). Contractor shall test stretches not exceeding 1 km. After successful organization and execution of tests the length may be extended to more than 2 km after approval of the Engineer- in -Charge.

The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. Complete setting of the thrust blocks. Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches. The testing conditions for the pipelines shall be as per the test pressures and condition laid out in IS 8329 for DI pipes.

The testing conditions for the pipelines are summarized as follows:

Maximum hydrostatic test pressure for DI K-7 / K9 pipes shall be 2.0 times of maximum design pressure in the pipeline.

Pre test and saturation period with addition of make-up water

Pressure: Test pressure

Duration: 3 hrs for DI pipes without cement mortar lining / 24 hrs for DI pipes with cement mortar lining

Pressure test with addition of make-up water

Pressure: Test pressure

Duration: 3 hrs

Test criteria for DI pipes: Q=1 litre / km per 10mm of pipe per 30 m test pressure per 24 hrs.

All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount 'Q', calculated by the above formula. All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test have been obtained.

9.0 PIPE LAYING

Excavation

The trench excavation of pipe line shall be in accordance with IS 12288. Pipe trenches shall be excavated to the lines and levels shown on the drawings or as directed by the Engineer. The depth of the excavated trench depth should be sufficient to provide a cover not less

than 1000 mm or as directed by the Engineer. It may be necessary to increase the depth of pipeline to avoid land drains or in the vicinity of roads, railways or other crossings. The width of the trench at bottom between the faces of sheeting shall be such as to provide 200 mm clearance on either side of the DI / PE pipe except where rock excavation is involved. No pipe shall be laid in a trench until the section of trench in which the pipe is to be laid has been approved by the Engineer.

The bottom of the trench shall be trimmed and levelled to permit even bedding of the pipes. It should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation shall be made at the joints of the pipes, so that the pipe is supported along its entire length.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.

Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2m above surface of the ground. There shall be two rails, one near the top of the post and the other about 450mm above the ground and each shall be from 50mm to 70mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m high shall be formed where required by the Engineer for further protection.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by the Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes and covers etc. so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organizations or otherwise as the Engineer may direct.

Contractor shall take into account additional excavation if any as the Engineer may require for locating the position of water pipes, drains, sewers etc. or any other works which may be met with. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as the Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, sewage etc.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than the minimum requirement. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of the Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches / pits shall be saturated with water well rammed wherever the Engineer may consider it necessary to do so.

Wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60cm in depth and 90 cm in length shall be made at joints in order to facilitate welding. The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic.

The Contractor has to ensure the following:

Safety protections as mentioned above have to be incorporated in the work process

Hindrances to the public have to be minimised

The trench must not be eroded before the pipes are laid

The trench must not be filled with water when the pipes are laid

The trench must not be refilled before laying of the pipes

Dewatering

During the excavation, if subsoil water is met with Contractor shall provide necessary equipment and labourers for dewatering the trenches. The Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by the Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, the Contractor shall take necessary permission from the local authorities.

Special Foundation in Poor Soil

Where the bottom of the trench and sub grade is found to consist of material which is unstable to such a degree that in the opinion of the Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings be prepared by the Contractor and as instructed by the Engineer shall be constructed.

Wooden Shoring

Contractor shall suitably design polling boards, waling and struts to meet different soil conditions that might be encountered in excavating trenches / pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and /or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

The Engineer may order portions of shoring to be left in the trenches /pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. The Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

Steel Plate Shoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench / pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances, the Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc., as per the instructions, manner and method directed by the Engineer. Contractor shall supply pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Employer's Requirements.

Bedding

The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may injure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continuous contact between the trench and the entire pipe barrel between socket holes. In case of sandy strata no separate bedding is required. However the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. In case excavation is through rock or Black Cotton Soil, bedding should be provided to give complete contact between the bottom of the trench and the pipe. The bedding material shall be well graded sand or another granular material passing 5.6 mm sieve suitably compacted/rammed. The bedding material shall be clean, well graded and free from topsoil, clay or vegetable matter and to the approval of the Engineer. The thickness of bedding shall be a minimum of 150 mm or 0.5x(Outer dia) whichever is maximum.

Boning Staves and Sight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation,

so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by the Engineer.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of metres and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of the tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of the pipe etc. as the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The center line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the center lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail. The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point. The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and the Engineer gives permission to proceed with the backfilling.

Laying of Pipes and Fittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Employer / Engineer. Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings / specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings /specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by the Engineer.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of

pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings/specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 ½0. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes. The cutting of pipe for inserting valves, fittings, or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

External protection

All underground pipe work having a cover less than 1.0 m shall be encased with M 15 concrete of minimum 200 mm thick all around.

Flexibility in Pipe work

The Contractor shall provide flexibility in the pipe work at joints in the main structures and shall submit proposals for the approval of the Engineer. Flexible joints or collars and cut pipes shall be allowed on all pipe work where necessary to allow for some margin of error in the building work. Wherever possible flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrusts as a whole so that external anchorages may be kept to a minimum. Flexible joints shall also be provided for case of erection and future dismantling. Particular care shall be taken to ensure that pipe work thrusts are not transmitted to machinery or associated apparatus. The Contractor shall indicate on his detailed drawings what thrust blocks are required.

Puddle Flanges

Puddle flanges shall be fitted to pipes where the structure through which they pass is required to take thrust resulting from the pipe. Puddle flanges shall also be fitted where a water barrier is required. All puddle flanges shall be clearly shown on the drawing and the resultant thrust clearly indicated. Puddle flanges shall only be fitted with the Engineer prior approval.

Support of Pipe work and Accessories

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valve, meters, strainers, and other devices mounted in the pipe work shall be supported independently of the pipes to which they connect. All brackets or other forms of supports, which can conveniently be so designed, shall be rigidly built up of steel by riveting or welding

in preference to the use of castings. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer. After the collars and boxes or other fitting have been fixed in position, the floors, walls and roof structure will be made good by the Contractor.

Thrust Blocks

Thrust Blocks shall be provided, to counteract hydraulic thrust, at places wherever directed by the Engineer.

Jointing

Jointing for pipes and fittings / specials shall be done in accordance with the relevant Employer's Requirement depending upon the type of pipes being used.

Valve chamber

Valve chambers shall be constructed according to approved drawings suitable for the respective valve. They shall be constructed in RCC. The chambers shall be constructed after the laying of the pipes and the assembly of specials and valves. The size of the chambers shall be according to the following criteria/ as per direction of Engineer.

- Minimum distance of flanges from walls : 30 cm
- Minimum distance of sockets from walls : 30 cm
- Minimum distance between highest point of equipment and roof slab : 30 cm

Pipes passing through walls should be coated by two layer of soft material (hessian felt) to allow for differential settling and longitudinal expansion if directed by Engineer. Only metallic pipes may be cast into the walls for anchoring purposes.

Testing and Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant Employer's Requirement and as per the relevant IS codes of the pipe material used.

Backfilling

Backfilling of trenches for pipes shall be commenced after the pipes have been successfully tested. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

All fill material shall be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed of as directed by Engineer after the filling work is completed.

Back fill material

To the extent available, selected surplus soils from excavations shall be used as backfill provided that it complies to IS 12288 and such material consists of loam, clay, sand, fine gravel or other materials which are suitable for backfilling. All backfill material shall be free from clods, salts, sulphates, cinders, ashes, slag, refuse, rubbish, lumps, vegetable or

organic material, lumpy or frozen material, boulders, rocks or stone or other foreign material. All lumps of earth shall be broken or removed. If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Engineer.

Backfilling of Pipe Trenches

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top:

Zone A	From the bottom of the trench to the level of the centre line of the pipe in case of excavation in soil and from the top of the pipe bedding to the level of the centre line of the pipe in case of excavation in rock.	Backfilling in this zone shall be done with carefully selected excavated material compacted by hand in layers not exceeding 150 mm with 95% proctor density. The back-filling material shall be deposited in the trench for its full width of each side of the pipe, specials and appurtenances simultaneously. Special care shall be taken to avoid damage of the pipe and the coating or moving of the pipe.
Zone B	From the level of the centre line of the pipe to a level 300 mm above the top of the pipe.	Backfilling in this zone shall be done with carefully selected excavated material compacted by hand or approved mechanical methods in layers not exceeding 150 mm with 95% proctor density, special care being taken to avoid injuring or moving the pipe.
Zone C	From a level 300 mm above the top of the pipe to the top of the trench.	Backfilling in this zone shall be done with suitable excavated material and shall be compacted using mechanical compactors in layers not exceeding permissible thickness relevant to the type of mechanical compactors deployed to achieve 95% Proctor Density.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back-fill to the subgrade of the structures shall be made with sand in accordance with IS 12288.

The Contractor shall take proper precautions against the risks of floatation. Should any section of the pipeline be affected by floatation shall be removed and reinstalled to the satisfaction of the Engineer

The Contractor shall carry out field tests that on each layer to confirm that the specified density has been obtained.

All excavations shall be backfilled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Engineer, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof, and the manner of depositing and compacting shall be subject to the approval of the Engineer, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

Trenches crossing a road shall be backfilled with selected material placed in layers not exceeding 15 cm in thickness after compacting, wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the Contractor at his expense.

The Contractor shall at his own expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.

On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The Contractor shall not use backfilling for disposal of refuse or unsuitable soil.

Disinfection of Water Mains

The mains intended for potable water supplies should be disinfected before commissioning them for use. Special care should be taken to ensure disinfection of new mains. Among possible sources of contamination are sewer drainage, contaminated soil in the trench, contamination from workmen or their equipment or both and unavoidable foreign material present in the trench during construction.

Education of crew members as to the need for avoiding contamination of the main during construction is fundamental. Contractors and workmen should be thoroughly familiar with all pertinent state and local requirements governing installation of mains. All sewers, water mains and other underground conduits should be located prior to construction, relocated, if necessary, to prevent contamination during construction. Pipe should be strung on high ground. At all times when construction is not actually in progress, watertight plugs should be installed in all pipe openings. Gunny sack and rags are not adequate. Provision should be made to pump any other water that might collect in the trench. Special care should be taken to avoid contamination of valves, fittings, and pipe interiors, both before and during construction each of them should be inspected and, if necessary, cleaned before installation.

After pressure testing the main, it should be flushed with clean water at sufficient velocity to remove all dirt and other foreign materials in the constructed pipeline. When this process has been completed, disinfection (using liquid chlorine, sodium or calcium hypochlorite) should proceed by one of the recommended methods as described in the following clauses

Continuous Feed

In this method, water from the distribution system or other approved source and the chlorine is fed at constant rate into the new main at a concentration of at least 20 mg/1. A property adjusted hypochlorite solution injected into the main with a hypo-chlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump may be used. The chlorine residual should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. All valves, hydrants, etc., along the main should be operated to ensure their proper disinfection. The water should remain in the main for a minimum of 24 hours. Following the 24 hours period no less than 10 mg/1 chlorine residual should remain in the main. The Contractor is requested to provide photo and take a record the value of chlorine residual at starting point and after 24 hours before completion of work. The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved. Waste chlorine residual water must be neutralized before it is discharged to any drainage.

Slug Method

In this method a continuous flow of water is fed with a constant dose of chlorine (as in the previous method) but with rates proportioned to give a chlorine concentration of at least 300 mg/1. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that contacts all interior surfaces of the main for a period of at least 3 hours. As the slug passes tees, crosses, etc., proper valves shall be operated to ensure their disinfection. This method is used principally for large diameter mains where continuous feed is impractical.

Regardless of the method used, it is necessary to make certain that backflow of the strong chlorine solution into the supplying line does not occur. Following the prescribed contact period, the chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating that throughout the rest of the system. Bacteriological tests as prescribed by the authorities should be taken, and if the results fail to meet minimum standards, the disinfecting procedure should be repeated and the results again tested before placing the main in service. If continuous feed method is difficult to apply, Retention Method shall be considered as alternative way. The area or pipe line to be disinfected shall be fed with chlorine solution from upstream under flowing water condition. The chlorine solution fed in the pipeline shall be kept for 1 day before measurement of residual chlorine is undertaken. After 3 days later, the chlorine residual value shall be tested at sampling points at upstream and at downstream end to check whether the value is in range or not. The Contractor shall provide photo and take a record the value of chlorine residual at starting point and after 24 hours before completion of work. The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved. Waste chlorine residual water must be neutralized before it is discharged to any drainage, as approved by Engineer.

Dynamic commissioning

The dynamic commissioning shall commence after the work has been physically completed to the satisfaction of the Engineer- in -Charge. It shall simulate the design and operation conditions which are as follows:

- Water being put into the system through overhead tank or direct pumping as the case maybe.
- Closing of the valves against full static or dynamic pressure.
- Operation of all valves including scour valves (open-close-open).
- Operation of all air valves.

10.GROUND WATER RECHARGE STRUCTURE

- Construction of intake chamber using minimum M25 grade concrete as per approved drawing. The intake chamber shall have provision intake channel, desilting chamber and bifurcation chamber.
- Supplying, laying in trenches, jointing un-plasticized PVC pipes & fittings of the following outside dia. for all classes including jointing with approved solvent cement by non-heat application method including testing as per specification and direction of Engineer-in-charge etc. all complete. [excluding earth work] 200mm OD. Rigid UPVC PIPES(IS:4985:2000)[Class-3] 6kg/cm². for piping arrangement from intake chamber to recharge pit, from recharge pit to storm water drain and bypass pipe.
- Geotextile Membrane- Supplying & laying of drainage composite around the slotted pipe. Geocomposite for planar drainage, realized by thermo bonding a draining core in extruded monofilaments with two filtering nonwoven geotextiles that may also be working as separation or protecting layers. The draining three dimensional core will have a "W" configuration as longitudinal parallel channels. Minimum thickness to be 7.2mm, with two filtering UV stabilized polypropylene nonwoven geotextile of minimum thickness of 0.75mm characteristic opening size (O90) of 110 micron and tensile strength of 8.0 kN/m that will be working as separation or protecting layer, geocomposite having in plane flow capacity of 2.1 L / (m.s) at hydraulic gradient of 1.0 & 20 kPa pressure and tensile strength of 18 kN/m , with mass per unit area of 740 gsm, supplied in the form of roll for easy transportation to site of work as per detailed specification all complete as per directions of Engineer in charge.
- Supplying, filling, spreading & leveling coarse sand of size range 1.5 mm to 2 mm in recharge pit, in required thickness over gravel layer, for all leads & lifts, all complete as per direction of Engineer -in charge.
- Supplying, filling, spreading & levelling gravels of size range 5 mm to 10 mm, in the recharge pit, over the existing layer of boulders, in required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge.
- Supplying, filling, spreading & levelling stone boulders of size range 5 cm to 20 cm, in recharge pit, in the required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge.
- Supplying all labour, T&P for drilling a perfectly vertical bore hole of specified dia for specified depth below GL through consolidated & unconsolidated rock with combination drilling rig as required to suit the site conditions including use of own rig with its accessories of 200/150mm dia PVC/GI/MS pipe for housing fitted with socket & with or without well screen as per the necessity for the soft, medium, hard & boulder formation. (PVC/GI/MS casing pipes if required to prevent collapse of over burden is to be fitted by the contractor including lowering & withdrawing after completion of tube well). 200mm dia to 400mm dia in over burden portion including packing of gravel supplied by the contractor for 400mm bore only. Up to a depth of 100m or as approved by engineer based on hydrogeological test report.
- Providing and lowering the following size PVC casing pipe with or without slotted pipes as per the necessity from G.L up to the required depth & fitted & fixed up in perfectly vertical position including cutting & threading & slotted pipes & supplying & fixing all jointing materials T & P etc all complete & keeping the top of the casing pipe threaded

including plugging tube wells to prevent entry of foreign materials etc all complete as per the direction of engineer in charge. 200mm dia PVC casing pipe, 0 to 60 m depth or as directed by engineer in charge. Pipe shall confirm to schedule 80.

- The M.S. ladder shall be provided & fixed to give access to the top slab from bottom slab gallery. The ladder shall be comprising of 65 mm x 65 mm x 6 mm. M. S. angles placed at 450 mm apart with 16 mm M. S. bars in double rows as steps at 200 mm center to center distance. The ladder shall be properly fixed at site as directed and bottom & top shall be properly embedded in 1:2:4 C.C. block. In order to have stiffness to the ladder cross supports or stiffeners at suitable intervals as directed shall be provided of suitable M.S. flats duly embedded in walls and welded to the ladder. The M. S. ladder & supports shall be provided with three coats of anticorrosive paint as directed.

3.1 GEOLOGICAL DATA

- Samples of drill cuttings from different strata should be collected at every 2.0 metre depth drilled or at closer intervals if a change in the strata is met with.
- The samples should be dried and stored in neat cloth or polythene bags which should be levelled clearly indicating the depth range of the strata.
- After the drilling has reached sufficient depth, all the samples of strata collected should be carefully examined and analysed and a strata chart in the form given below should be prepared, indicating the probable strata which are likely to yield water.

S.NO.	LITHOLOGY	DEPTH RANGE	THICKNESS
1	Clay, top soil, brown etc.		
2	Clay, brown, silty with trap gravel		
3	Gravel, consisting of trap, sub-angular to rounded with some trap sand, calcareous material, etc.		
4	Gravel, consisting of trap, sub-angular to rounded mixed with clay and kankar.		
5	Gravel, consisting of trap, sub-angular to rounded (pea size), with angular pieces of fresh or weather trap etc.		
6	Gravel, consisting of trap (size up to 50 mm in dia) with very coarse trap sand.		
7	Gravel, consisting of trap (pea size) with coarse sand, consisting of altered trap, agate, flint, chert and fresh calcite		
8	Clay, brown, yellowish brown, chocolate		

	or grey, hard, plastic with a little angular to sub-angular trap gravel.		
9	Trap basalt		

3.2 DRILLING TIME LOG

- As the drilling progresses, an accurate drilling time log shall be kept indicating the time taken to drill each 3.0 m depth. This log will enable interpretation regarding the nature of the formations (hard, soft, unconsolidated, etc.) which has a bearing on the water yielding capacity of the formations.
- After the completion of drilling up to the desired depth, the borehole shall be electrically logged to collect adequate information about the conditions of the formations.

3.3 DESIGN AND LOWERING OF PIPE ASSEMBLY

GENERAL

- From the data collected about the nature of the aquifers met, the Contractor shall design the bores in respect of size and length of the housing pipe, blank pipes, pea-gravel shrouded slotted or perforated pipes, and bail plug etc. It should be ideal to have the length of the slotted pipes or screens exactly equal to the thickness of the aquifers to be tapped. However, in practice the actual length of each of the housing pipes, blank pipes and pea gravel shrouded pipes may be kept as multiple of the length of the pipes available in the market, provided there is no difficulty, such as intrusion of water from a saline aquifer and gradation in the texture of formation material.
- The sizes of perforation or slots for pea-gravel shrouded strainer pipes shall be so designed that the total opening available is adequate to pass the water in filtering from the aquifer without exceeding the critical velocity.
- In case of patented pea-gravel shrouded strainers, the manufacturer's directions shall be followed to obtain the best results.
- The circumferential, longitudinal or spiral seams of the metal casing shall be welded in such a manner as to develop strength nearly equal to that of the parent metal. It is preferable to use seamless steel pipes.

PLUMBNESS AND ALIGNMENT

- The verticality shall be checked immediately after the housing pipes are installed but prior to commencing the gravel filling.
- If the pipe assembly is found inclined before filling the gravels, the assembly shall be pulled in desired direction by applying force through jacks or by other means with a view to rectify the slantness and bring the pipe assembly within the permissible limits of verticality. The gravel filling operation shall then be undertaken immediately after the verticality has been rectified and tested. If necessary, remedial measures should also be adopted in between by means of jacks or any other means to bring the pipe assembly within the permissible limits of verticality.

Technical Submittal

Ventilation Fans

Document Number: Technical Submittal-17049-R9-CRK-Smart City, Rourkela, Odisha -0121

Project: Smart City, Rourkela, Odisha (CC Building).

List of Contents

KRUGER VENTILATION INDUSTRIES (INDIA) PVT LTD. .

COMPANY PROFILE

Dear Sir / Madam,

Kruger Ventilation Industries (India) Pvt Ltd. is a wholly owned subsidiary of Kruger Group Singapore. Set up in November 1996, the Indian subsidiary has seen a consistent annual growth rate of more than 10% over the last two decades. Today, the company is acknowledged as the Leader in the manufacturing & supply of Ventilation products in the Indian HVAC Industry.

Kruger has a wide range of products catering to varied applications including the fans for Air-conditioning equipment's, commercial & Industrial ventilation.

Kruger believes in staying closer to the customers so as to understand the customer requirements & support the market with quick response. Kruger India imports few fan components from the principal manufacturing factory at Kruger Thailand. Kruger India has two manufacturing and assembly factories in India. One, having an area of 12,000 m^2 located on Mumbai Nashik Highway, about 60kms from Thane, Maharashtra. It caters to West & South region of the country. Another assembly plant **{Kruger Ventilations Industries (North India) Pvt. Ltd.}** has an area of 12,000 m^2 at Bahadurgarh (Haryana). It caters to North & Eastern region of the country. Kruger India has Sales offices in the metro cities. Kruger India, today, is a team of 350 plus professionals including the staff & technicians.

Kruger believes in providing the products as per internationally recognized standards and thus major Kruger products are licensed to bear AMCA i.e. certified for Air & Sound performance as per AMCA standards. Kruger products have been approved, recommended & preferred by most of the HVAC consultants & the end clients in India. Kruger products worth INR 700 plus crores have been installed in more than 10,000 project facilities all over the country during past 16 years and are performing satisfactorily.

Kruger fans are preferred by the major OEMs manufacturing HVAC equipment's in India and it occupies the market share of about 60% in this segment.

The company is focussed to support the Indian market with the faster deliveries and looking into the potential growth in the Indian market Kruger India has acquired a land of 36 Acres on Mumbai-Nashik highway and the first phase operations has started in August 2014 and has further expansion plans.

The company strives to organize its resources with an uncompromising dedication to creating value, with commitment to Total Excellence for our customers.

Thanks & Best Regards

For Kruger Ventilation Industries (India) Pvt Ltd.

Guruprasad Tiwari
(General Manager)

KRUGER VENTILATION INDUSTRIES (INDIA) PVT. LTD. .

Overview:

Established in Singapore since 1985, Kruger Ventilation is a full subsidiary company of Soler & Palau Ventilation Group. Kruger is a leading supplier of energy efficient ventilation solutions for residential and commercial buildings, industrial applications and infrastructures. Currently Kruger established 18 business units in Asia Pacific Region.

With our wealth of knowledge and know-how, Kruger believes in creating value for customers simply by understanding their needs and delivering expectations. We are proud to present to you our products that are of high quality, competitive in pricing and of international standards. However, we will not stop here, we will be constantly seeking ways to continue providing our customers with good quality service and products. We recognise our customer's importance and their requirements as one of our key strategy to achieve better customer service. To propel this ambition further, Kruger Research team has been launched to engineer advanced fan systems to expand its range of ventilation systems to provide a wider selection. Our team of engineers is determined to research and develop the most effective solution to meet our customer's ventilation needs.

Our success lies in our team of dedicated staff, excellent management and good research facilities. Our ambition to establish Kruger as a regional leading ventilation supplier had remained focused and undisrupted.

Product Range :

- **Residential/commercial segment**:
  Most comprehensive range of products available - Axial, Centrifugal, in-line, Roof exhaust,Mixed flow, Domestic, Smoke-spill fans, Jet fans.

- **Tunnel Ventilation segment :**
- Axial fans:
  1. Air volume upto 450 m3/s (unidirectional) & 160 m3/s (reversible)
  2. Pressure upto 4000 (Pa)
- Jet fans:
  1. Size 560mm to 1600 mm
  2. Thrust – upto 3800 N

Guaranteed Quality & Performance :

- ISO 9001:2015 certification
- Most of the products are licensed by AMCA for Air and Sound Performance
- TUV-SUD high temperature certifications for smoke-spill fan
- AMCA Accredited Laboratory located in Bangkok
  (Test Chambers for Air Performance up to 100,000 CMH)
- All wheels are statically and dynamically balanced to ISO1940 and AMCA 204 - G2.5 standards.
- All fans after assembly are trim-balanced to ISO 1940 and AMCA 204 - G2.5.

KRUGER VENTILATION INDUSTRIES (INDIA) PVT. LTD.
Mumbai-Nasik Highway | Kalamgaon | Shahapur | Thane-421 601 | Maharashtra | India | Thane - 421601
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KRUGER VENTILATION INDUSTRIES (INDIA) PVT. LTD. .

International Standard & Certification

Total quality embraces continual research and development, rigorous testing and performance to international quality standards.

Most of our products are licensed to bear the AMCA seal (Air Movement and Control Association International, USA) for air and sound performance. In addition, all our fans are trim balanced to ISO 1940 G2.5 and the Smoke spill fan tested by TUV. In short, we strive for quality excellence. It's our commitment to performance.

AMCA STANDARDS:

AMCA International, backed by almost 80 years of standards development, is t the world's leading authority in the development of the science and art of engineering as relates to air movement and air control devices. AMCA International publishes and distributes standards, references, and application manuals for specifiers, engineers, and others with an interest in air systems to use in the selection, evaluation, and troubleshooting of air system components. Many of AMCA International's standards are accepted as American National Standards. A description of AMCA International's publications is contained in the Publications Catalogue. AMCA International, with member companies and laboratories in many industrialized countries around the world, is active on the technical committees of the International Standards Organization (ISO), and participates in the development of international standards for the industry.

ISO:

ISO is a network of the national standards institutes of 148 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. ISO occupies a special position between the public and private sectors. This is because, on the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations. Therefore, ISO is able to act as a bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users.

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KRUGER

KRUGER VENTILATION INDUSTRIES (NORTH INDIA) PVT. LTD.

QUOTATION | Document No. | KNI/MKTG/F/04/A | Rev.no - 01

Ref No : KNI-17049-R9-CRK-Smart City ,Rourkela,Odisha (CC Building)-0121

Date : 26/11/2022

M/S : [redacted].

A. TECHNICAL ANNEXURE:

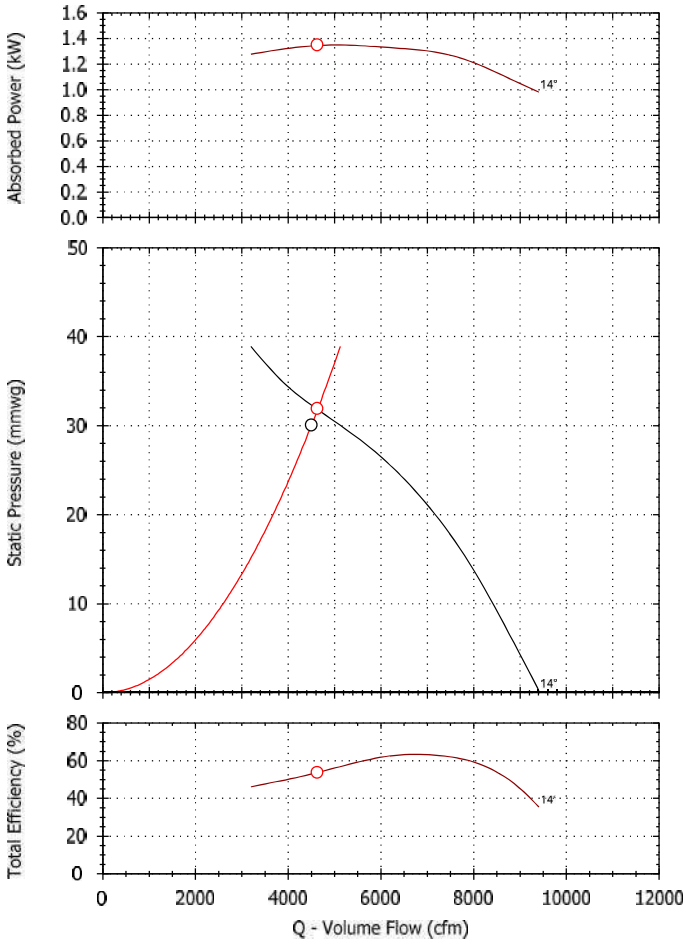
Sr. No	Capacity (CFM)	Static pressure (mmwg)	Block	Floor	Location	Fan Application	Fan Type	Fan Casing MOC	Fan Model	Outlet Vel. m/s	Abs. Power (Bkw)	Total Eff. %	* Noise Level dB(A) @ 3 m, Lab. Cond.	Fan RPM	Motor							Qty.
															KW	Pole	Ph	EFF Grade	Ins	Prot	Motor Make	
1	18000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-5, upper RHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/10**	7.04	6.33	59.4	81.2	960	7.5	6	III	IE2	H	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
2	18000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-5, upper RHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/10**	7.04	6.33	59.4	81.2	960	7.5	6	III	IE2	H	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
3	4500	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- Pump room, upper LHS	Fresh Air Supply	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/14**	5.53	1.35	53.7	71.2	1450	1.5	4	III	IE2	F	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
4	6000	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- Pump room, upper LHS	Normal Clean Air Exhaust	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/16**	7.17	1.53	60.8	71.7	1450	2.2	4	III	IE2	F	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
5	4000	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement S.T.P. Areazone-5, upper LHS	Fresh Air Supply	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/12**	4.84	1.16	52.4	69.9	1450	1.5	4	III	IE2	F	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
6	5000	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement S.T.P. Areazone-5, upper LH	Normal Clean Air Exhaust	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/14**	6	1.35	56.3	71	1450	1.5	4	III	IE2	F	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
7	28000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-4, LHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/18**	10.94	10	63.7	83.7	960	11	6	III	IE2	H	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
8	28000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-4, LHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/18**	10.94	10	63.7	83.7	960	11	6	III	IE2	H	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
9	28000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-4, LHS	Fresh Air Supply	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/18**	10.94	10	63.7	83.7	960	11	6	III	IE2	F	IP55	Havells/Rotomotive/BBL/ LHP/Hindustan Motors	**1**
10	1100	30	C & C Block	Ground Floor	Service Counter & Pantry	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-9T 4P-1 3SY**	Available Capacity Is 1100 CFM At Approx 30 MMWG			56	1300	0.35	4	I	STD	F	IP20	-	**2**
11	1000	30	C & C Block	Ground Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
12	1000	30	C & C Block	Ground Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
13	2000	30	C & C Block	Ground Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 400 4P-1 1S**	Available Capacity Is 2820 CFM At Free Flow			52	1355	0.268	4	I	STD	F	IP54	-	**2**
14	1000	30	C & C Block	1st Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
15	1000	30	C & C Block	1st Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
16	1000	30	C & C Block	1st Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	Available Capacity Is 1100 CFM At Free Flow			46	1420	0.112	4	I	STD	F	IP54	-	**1**
17	500	30	C & C Block	1st Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Circular Inline Fan	GSS Cabinet With Non-stalling backward curved impeller	**TSK II 315L**	Available Capacity Is 500 CFM At Approx 36 MMWG			60	2600	0.24	2	I	STD	B	IP44	-	**1**
18	150	-	C & C Block	1st Floor	Toilet	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	Available Capacity Is 295 CFM At Free Flow			36	1300	0.018	4	I	STD	B	IP44	-	**2**
19	1000	30	C & C Block	2nd Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
20	1000	30	C & C Block	2nd Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
21	1000	30	C & C Block	2nd Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	Available Capacity Is 1100 CFM At Free Flow			46	1420	0.112	4	I	STD	F	IP54	-	**1**
22	500	30	C & C Block	2nd Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Circular Inline Fan	GSS Cabinet With Non-stalling backward curved impeller	**TSK II 315L**	Available Capacity Is 500 CFM At Approx 36 MMWG			60	2600	0.24	2	I	STD	B	IP44	-	**1**
23	1000	30	C & C Block	3rd Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
24	1000	30	C & C Block	3rd Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
25	1000	30	C & C Block	3rd Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	Available Capacity Is 1100 CFM At Free Flow			46	1420	0.112	4	I	STD	F	IP54	-	**1**
26	200	-	C & C Block	3rd Floor	Store Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	Available Capacity Is 295 CFM At Free Flow			36	1300	0.018	4	I	STD	B	IP44	-	**2**
27	1000	30	C & C Block	4th Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
28	1000	30	C & C Block	4th Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	Available Capacity Is 1000 CFM At Approx 30 MMWG			47	1200	0.245	4	I	STD	F	IP20	-	**1**
29	1000	30	C & C Block	4th Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	Available Capacity Is 1100 CFM At Free Flow			46	1420	0.112	4	I	STD	F	IP54	-	**1**
30	600	30	C & C Block	5th Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7T 4P-1 3SY**	Available Capacity Is 600 CFM At Approx 32 MMWG			51	1150	0.245	4	I	STD	F	IP20	-	**1**
31	200	-	C & C Block	5th Floor	Toilet	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	Available Capacity Is 295 CFM At Free Flow			36	1300	0.018	4	I	STD	B	IP44	-	**5**
32	1000	30	C & C Block	5th Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	Available Capacity Is 1100 CFM At Free Flow			46	1420	0.112	4	I	STD	F	IP54	-	**1**
33	150	-	C & C Block	5th Floor	Store Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	Available Capacity Is 295 CFM At Free Flow			36	1300	0.018	4	I	STD	B	IP44	-	**1**
34	1200	30	C & C Block	5th Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-9 4P-1 3SY**	Available Capacity Is 1200 CFM At Approx 30 MMWG			51	1300	0.35	4	I	STD	F	IP20	-	**1**
35	1400	30	C & C Block	5th Floor	Kitchen	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 10-8 4P-1 3SY**	Available Capacity Is 1400 CFM At Approx 30 MMWG			59	1150	0.55	4	I	STD	F	IP20	-	**1**
																					TOTAL	**43**

Date	11/18/2022
Company	
Attention	
Project	
Reference	TDA710/12AA/7-7

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

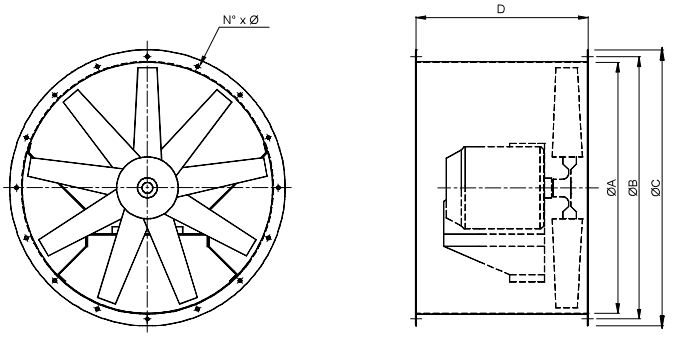
Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

Fan Selection	
Fan Type	TDA
Unit	TDA710/12AA/7-7 / 14°
Fan Quantity	1
Operating Conditions	Ducted
Required Volume	4,500 cfm
Required Static Pressure	30.0 mmwg
Air Volume	4,634 cfm
Static Pressure	31.8 mmwg
Velocity Pressure	1.87 mmwg
Total Pressure	33.7 mmwg
Outlet Velocity	5.53 m/s
Fan Total Efficiency	53.7 %
Fan Static Efficiency	50.8 %
Fan Speed	1450 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	1.35 kW
Motor Selection	
Recommended Motor	D90 4p (1.50 kW)
Motor Speed	1450 rpm
Service Factor	5 %
Operating Limits	
Max. Absorbed Power	-
Max. Fan Speed	-
Temperature (Min-Max)	-



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	83	90	86	85	83	80	77	74	94 dB
Lwo(Lin)	87	94	90	88	86	83	80	77	97 dB
Lwi(A)	57	74	77	82	83	81	78	73	88 dB(A)
Lpi(A)	40	57	61	65	67	65	62	56	72 dB(A)

Sound Pressure Level "Lpi" 3m from the inlet side, Room Conditions



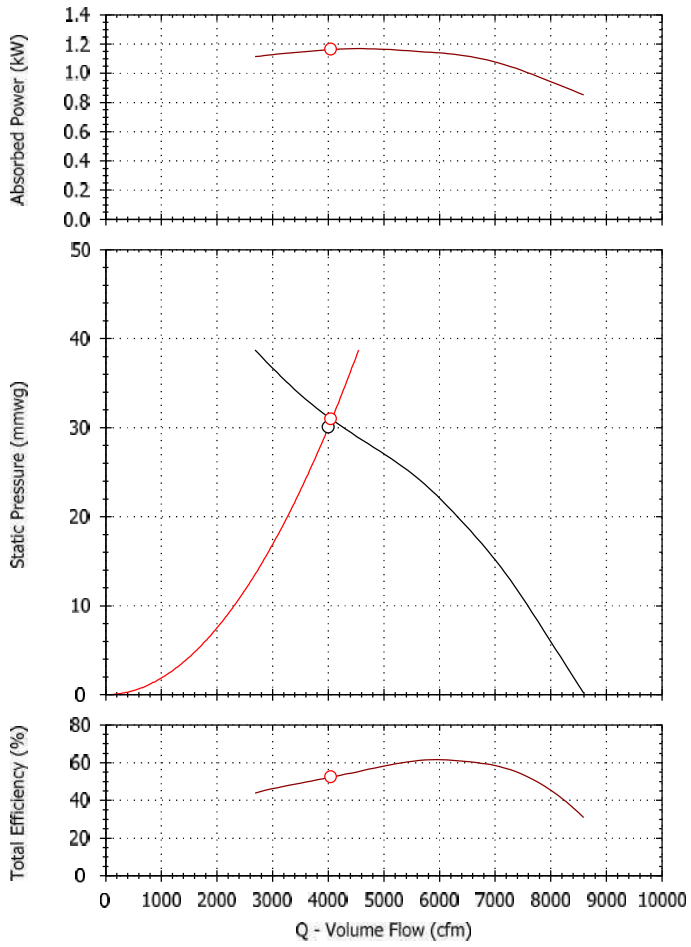
A	B	C	D	N°	Ø
710	755	810	500	18	12

Date	11/18/2022
Company	
Attention	
Project	
Reference	TDA710/12AA/7-7

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

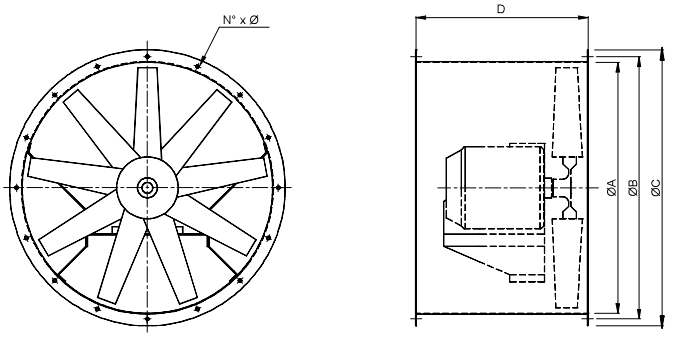
Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

Fan Selection	
Fan Type	TDA
Unit	TDA710/12AA/7-7 / 12°
Fan Quantity	1
Operating Conditions	Ducted
Required Volume	4,000 cfm
Required Static Pressure	30.0 mmwg
Air Volume	4,062 cfm
Static Pressure	30.9 mmwg
Velocity Pressure	1.44 mmwg
Total Pressure	32.4 mmwg
Outlet Velocity	4.84 m/s
Fan Total Efficiency	52.4 %
Fan Static Efficiency	50 %
Fan Speed	1450 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	1.16 kW
Motor Selection	
Recommended Motor	D90 4p (1.50 kW)
Motor Speed	1450 rpm
Service Factor	5 %
Operating Limits	
Max. Absorbed Power	-
Max. Fan Speed	-
Temperature (Min-Max)	-



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	82	89	85	84	82	79	76	73	92 dB
Lwo(Lin)	86	93	89	87	85	82	79	76	96 dB
Lwi(A)	56	73	76	81	82	80	77	72	87 dB(A)
Lpi(A)	39	56	60	64	65	63	60	55	70 dB(A)

Sound Pressure Level "Lpi" 3m from the inlet side, Room Conditions



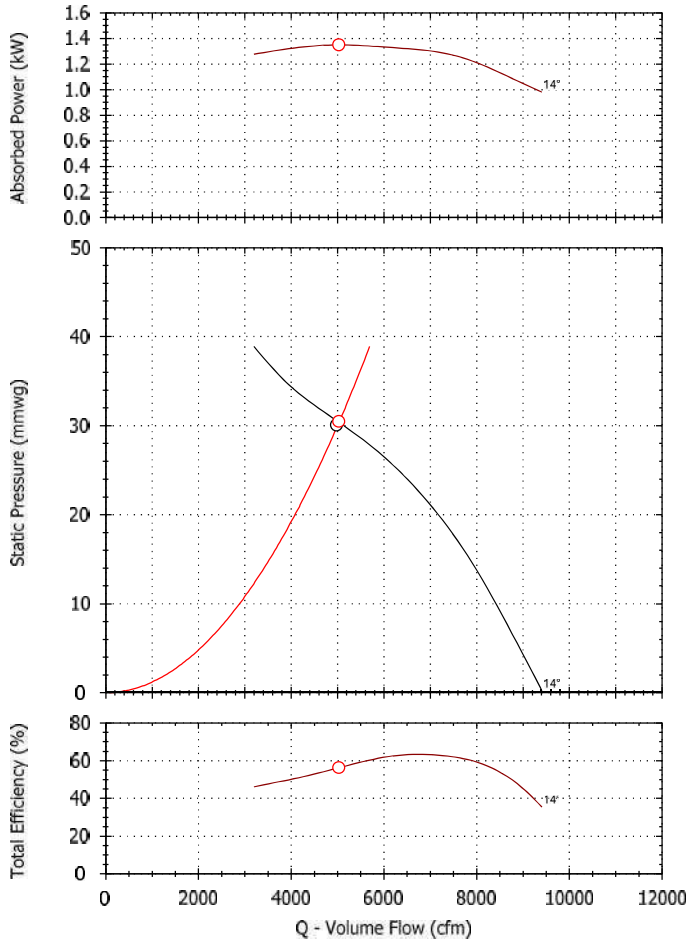
A	B	C	D	N°	Ø
710	755	810	500	18	12

Date	11/18/2022
Company	
Attention	
Project	
Reference	TDA710/12AA/7-7

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

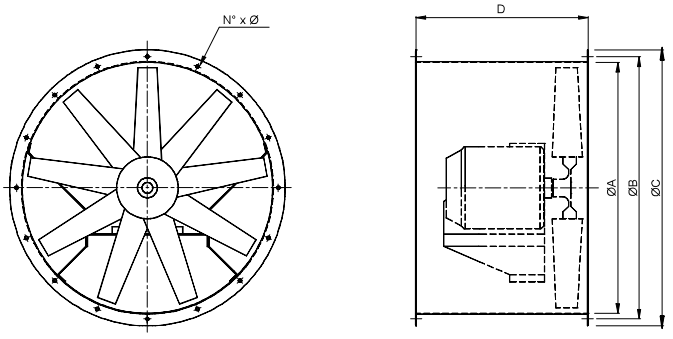
Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

Fan Selection	
Fan Type	TDA
Unit	TDA710/12AA/7-7 / 14°
Fan Quantity	1
Operating Conditions	Ducted
Required Volume	5,000 cfm
Required Static Pressure	30.0 mmwg
Air Volume	5,031 cfm
Static Pressure	30.4 mmwg
Velocity Pressure	2.21 mmwg
Total Pressure	32.6 mmwg
Outlet Velocity	6.00 m/s
Fan Total Efficiency	56.3 %
Fan Static Efficiency	52.5 %
Fan Speed	1450 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	1.35 kW
Motor Selection	
Recommended Motor	D90 4p (1.50 kW)
Motor Speed	1450 rpm
Service Factor	5 %
Operating Limits	
Max. Absorbed Power	-
Max. Fan Speed	-
Temperature (Min-Max)	-



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	83	90	86	85	83	80	77	74	94 dB
Lwo(Lin)	87	94	90	88	86	83	80	77	97 dB
Lwi(A)	57	74	77	82	83	81	78	73	88 dB(A)
Lpi(A)	40	57	61	65	66	65	61	56	71 dB(A)

Sound Pressure Level "Lpi" 3m from the inlet side, Room Conditions



A	B	C	D	N°	Ø
710	755	810	500	18	12

Date	11/18/2022
Company	
Attention	
Project	
Reference	TDA710/12AA/7-7

Kruger Ventilation Industries Pte Ltd
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Singapore 639141

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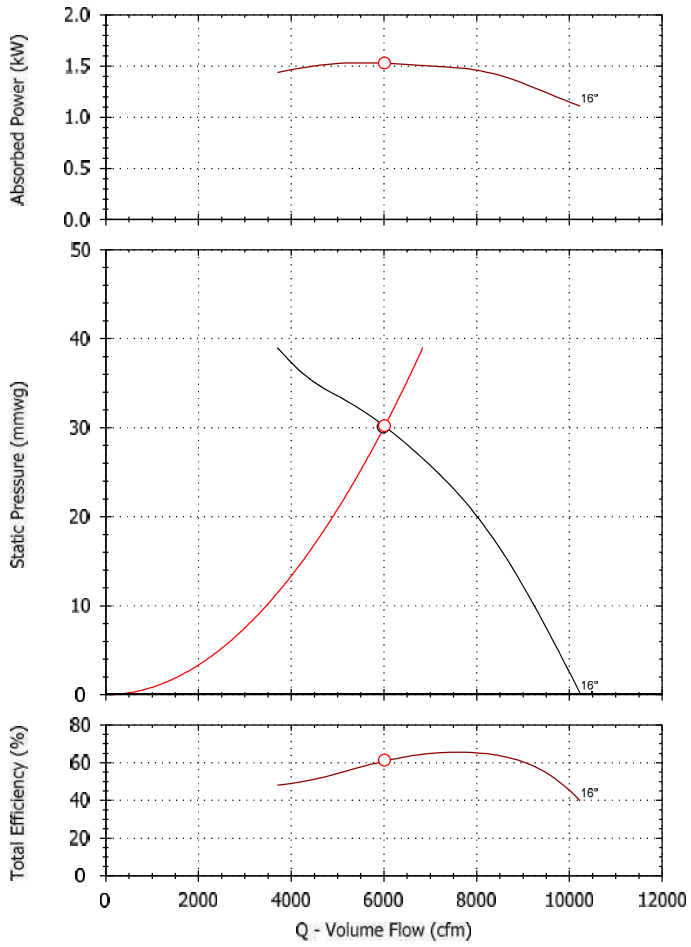
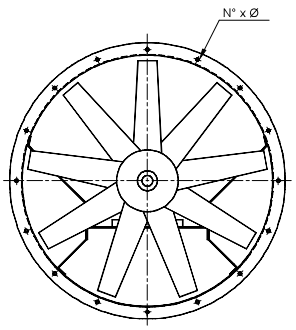
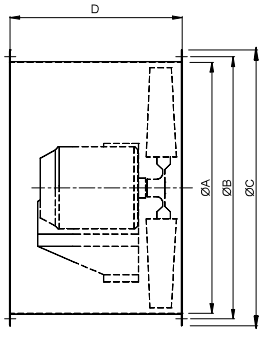
Fan Selection	
Fan Type	TDA
Unit	TDA710/12AA/7-7 / 16°
Fan Quantity	1
Operating Conditions	Ducted
Required Volume	6,000 cfm
Required Static Pressure	30.0 mmwg
Air Volume	6,015 cfm
Static Pressure	30.1 mmwg
Velocity Pressure	3.16 mmwg
Total Pressure	33.3 mmwg
Outlet Velocity	7.17 m/s
Fan Total Efficiency	60.8 %
Fan Static Efficiency	55 %
Fan Speed	1450 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	1.53 kW
Motor Selection	
Recommended Motor	D100 4p (2.20 kW)
Motor Speed	1450 rpm
Service Factor	5 %
Operating Limits	
Max. Absorbed Power	-
Max. Fan Speed	-
Temperature (Min-Max)	-



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	84	91	87	86	84	81	78	75	94 dB
Lwo(Lin)	88	95	91	89	87	84	81	78	98 dB
Lwi(A)	57	75	78	82	84	82	79	74	89 dB(A)
Lpi(A)	41	58	62	66	67	65	62	57	72 dB(A)

Sound Pressure Level "Lpi" 3m from the inlet side, Room Conditions





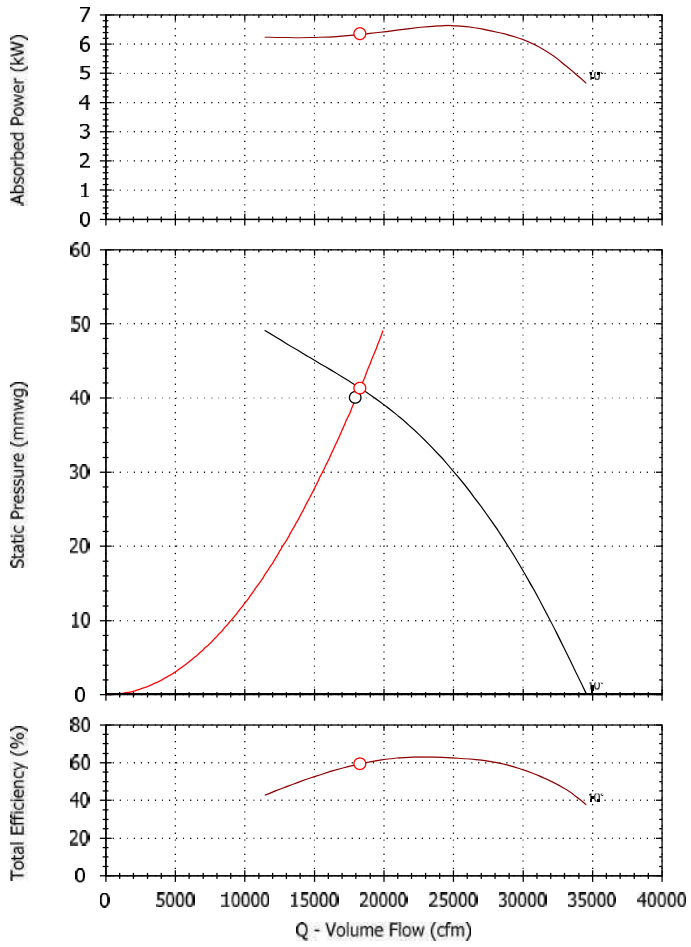
A	B	C	D	N°	Ø
710	755	810	500	18	12

Date	11/18/2022
Company	
Attention	
Project	
Reference	TDA1250/25BJ/6-6

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

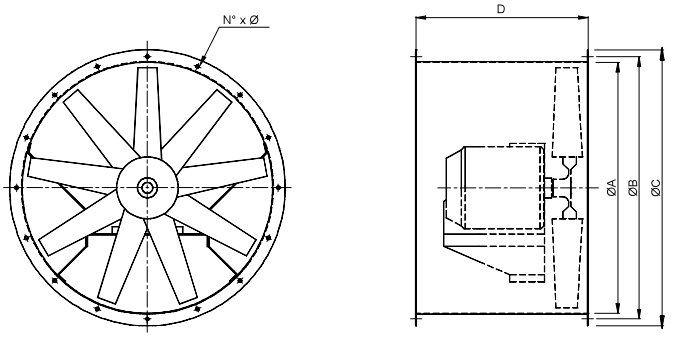
Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

Fan Selection	
Fan Type	TDA
Unit	TDA1250/25BJ/6-6 / 10°
Fan Quantity	2
Operating Conditions	Ducted
Required Volume	18,000 cfm
Required Static Pressure	40.0 mmwg
Air Volume	18,296 cfm
Static Pressure	41.3 mmwg
Velocity Pressure	3.04 mmwg
Total Pressure	44.4 mmwg
Outlet Velocity	7.04 m/s
Fan Total Efficiency	59.4 %
Fan Static Efficiency	55.3 %
Fan Speed	960 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	6.33 kW
Motor Selection	
Recommended Motor	D160 6p (7.50 kW)
Motor Speed	960 rpm
Service Factor	5 %
Operating Limits	
Max. Absorbed Power	-
Max. Fan Speed	-
Temperature (Min-Max)	-



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	90	91	101	94	92	89	86	83	103 dB
Lwo(Lin)	94	95	105	97	95	92	89	86	107 dB
Lwi(A)	64	75	92	91	92	90	87	82	98 dB(A)
Lpi(A)	47	59	76	75	76	74	71	66	82 dB(A)

Sound Pressure Level "Lpi" 3m from the inlet side, Room Conditions



A	B	C	D	N°	Ø
1250	1315	1380	1000	24	12

Date	11/18/2022
Company	
Attention	
Project	
Reference	TDA1250/25BJ/6-6

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

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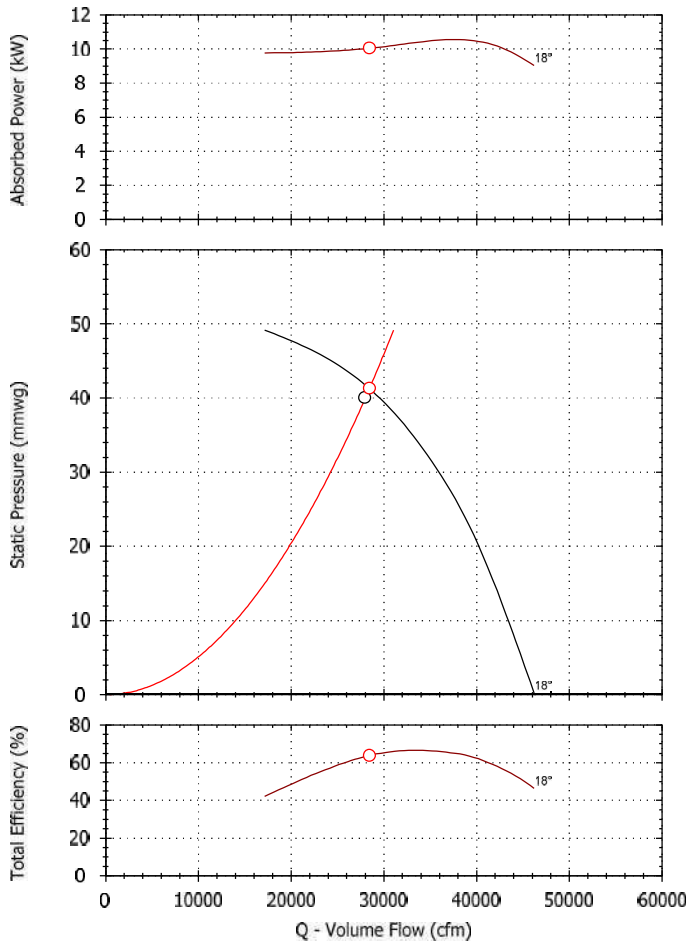
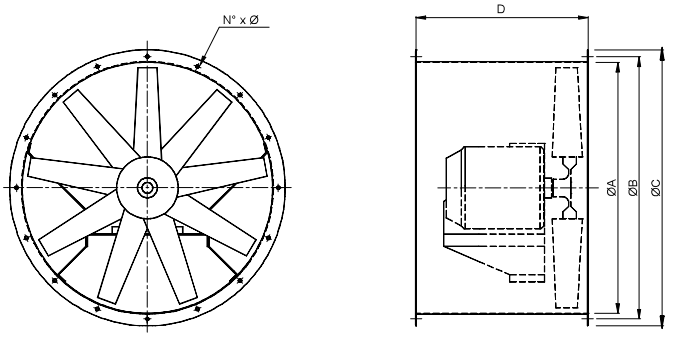
Fan Selection	
Fan Type	TDA
Unit	TDA1250/25BJ/6-6 / 18°
Fan Quantity	3
Operating Conditions	Ducted
Required Volume	28,000 cfm
Required Static Pressure	40.0 mmwg
Air Volume	28,438 cfm
Static Pressure	41.3 mmwg
Velocity Pressure	7.34 mmwg
Total Pressure	48.6 mmwg
Outlet Velocity	10.94 m/s
Fan Total Efficiency	63.7 %
Fan Static Efficiency	54.1 %
Fan Speed	960 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	10.0 kW
Motor Selection	
Recommended Motor	D160 6p (11.0 kW)
Motor Speed	960 rpm
Service Factor	5 %
Operating Limits	
Max. Absorbed Power	-
Max. Fan Speed	-
Temperature (Min-Max)	-



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	93	94	104	97	95	92	89	86	106 dB
Lwo(Lin)	97	98	108	100	98	95	92	89	109 dB
Lwi(A)	67	78	95	94	95	93	90	85	101 dB(A)
Lpi(A)	50	61	78	77	78	76	73	68	84 dB(A)

Sound Pressure Level "Lpi" 3m from the inlet side, Room Conditions



A	B	C	D	N°	Ø
1250	1315	1380	1000	24	12

In-Line Direct Driven Fan – **CCE Series**

- *Cabinet is manufactured in galvanized sheet steel.*
- *Incorporates a direct driven, DIDW forward curved centrifugal fan.*
- *Removable access panel on both sides for easy access to fan and motor.*
- *Flanged inlet and outlet for easy ductwork connection.*
- *Operating temperature -40°C to +40°C*

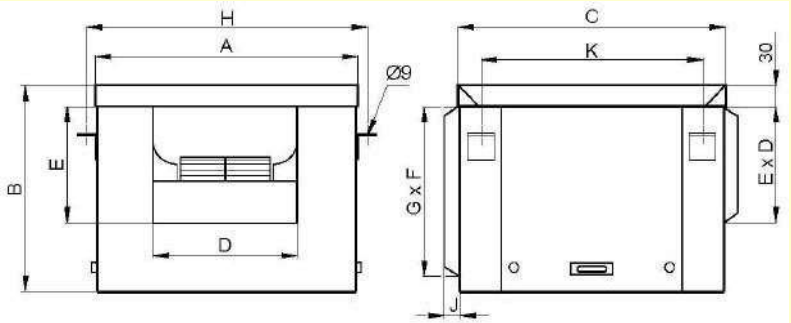
Optional Features:

- *Internal Insulation.*
- *Filter with throwaway media.*
- *Different discharge orientation.*

Kruger Ventilation Industries (India) Pvt Ltd certifies that the **CCE series** shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

Sr. No 11,12,14,15,19, 20,23,24,27,28

Dimension



Model	A	B	C	D	E	F	G	H	J	K	Weight (kg)
CCE 140	403	316	268	198	111	210	160	441	25	233	11
CCE 160	453	356	308	204	204	230	270	490	25	265	16
CCE 7-7	442	401	392	263	232	240	344	491	25	340	18
CCE 8-8	502	451	442	291	260	291	384	549	25	379	21
CCE 9-7T	572	401	393	236	266	348	322	621	25	340	24
CCE 9-7	573	451	442	236	266	348	382	619	25	378	27
CCE 9-9T	572	401	393	302	266	348	322	621	25	340	25
CCE 9-9	573	451	442	302	266	348	382	619	25	378	27
CCE 10-8	652	561	502	269	293	410	462	699	25	431	33
CCE 10-10	652	561	502	335	293	410	462	699	25	431	35
CCE 12-9	743	631	573	313	345	510	547	790	25	526	42
CCE 12-12	743	631	573	399	345	510	547	790	25	526	44

Sr no 30
Sr no 10
Sr no 34
Sr no 35

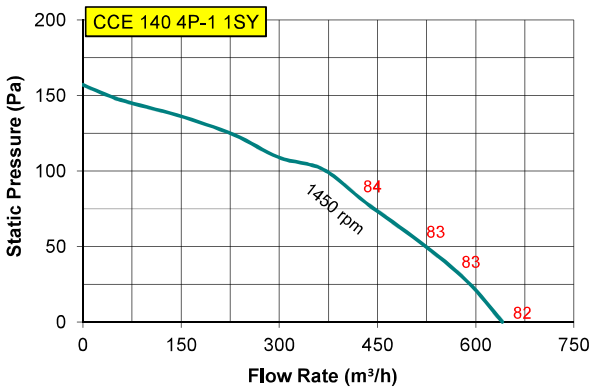
All dimension in mm.

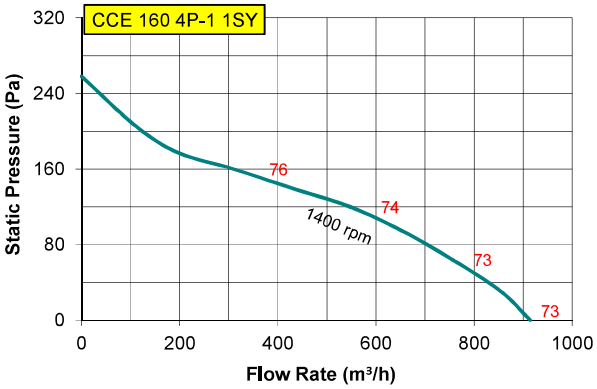
Technical data

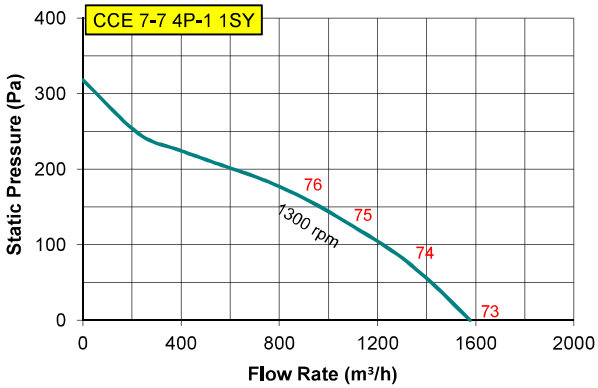
Model	Max Q (m^3/h)	Motor Installed Power (W)	Maximum Motor Input Power (W)	Motor Protection	Phase	Hz	Maximum Current (A)	Voltage (V)	Capacitor (µF/V)	Insulation Class	Lp (A) at 3m free discharge (dB (A))*	Speed (RPM)
CCE 140 4P-1 1SY	641	70	112	IP20	1	50	1	220	4.0/450	F	61	1450
CCE 160 4P-1 1SY	914	70	148	IP20	1	50	1	220	4.0/450	F	52	1400
CCE 7-7 4P-1 1SY	1577	165	255	IP20	1	50	1	220	7.5/450	F	52	1300
CCE 8-8 4P-1 1SY	1613	165	328	IP20	1	50	1	220	7.5/450	F	50	1300
CCE 9-7T 4P-1 3SY	1879	245	560/500/430	IP20	1	50	2.6/2.3/2.1	220	7.5/400	F	51	1200/1150/1100
CCE 9-7 4P-1 3SY	2084	245	590/500/430	IP20	1	50	2.7/2.5/2.0	220	7.5/400	F	47	1200/1150/1100
CCE 9-9T 4P-1 3SY	2426	350	780/520/360	IP20	1	50	3.5/2.5/1.8	220	12.5/450	F	56	1300/1100/800
CCE 9-9 4P-1 3SY	2574	350	800/520/360	IP20	1	50	3.6/2.4/1.7	220	12.5/450	F	51	1300/1100/800
CCE 10-8 4P-1 3SY	3639	550	1370/1120/940	IP20	1	50	6.3/5.2/4.5	220	16.0/450	F	59	1300/1250/1150
CCE 10-10 4P-1 3SY	3857	550	1420/1100/950	IP20	1	50	6.6/5.2/4.6	220	16.0/450	F	59	1300/1250/1150
CCE 12-9 6P-1 3SY	4547	709	1150/700/450	IP20	1	50	5.8/3.6/2.5	220	12.5/450	F	59	940/820/620
CCE 12-12 6P-1 3SY	5200	709	1220/700/450	IP20	1	50	6.2/3.7/2.5	220	12.5/450	F	62	940/820/620

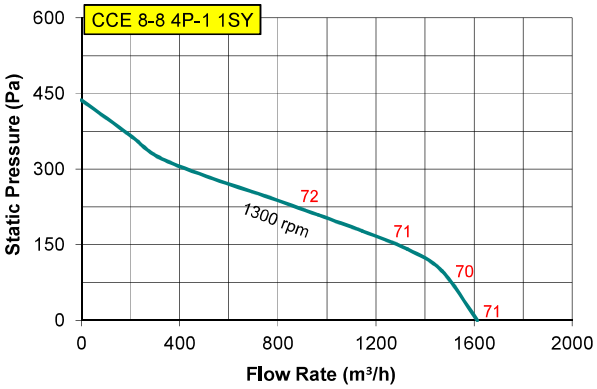
Sr no 30
Sr no 34
Sr. No 11,12,14,15,19, 20,23,24,27,28
Sr no 10
Sr no 35

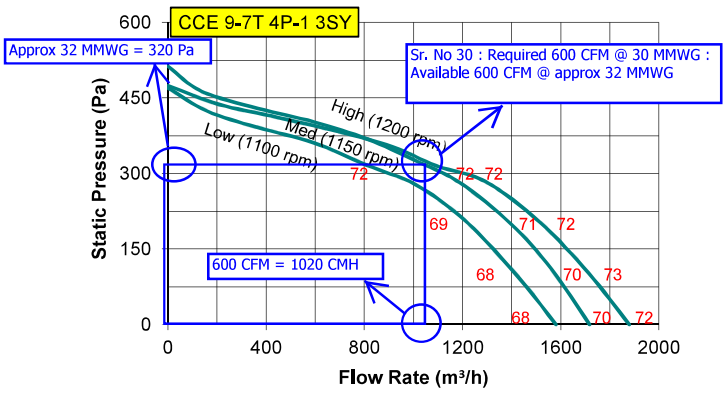
- Values shown are for inlet Lwi(A) sound power levels for installation type D – Ducted inlet, Ducted outlet. The A-weighted sound ratings shown have been calculated per AMCA International Standard 301. Ratings include the effects of duct end correction.
- Performance certified is for installation type D – Ducted inlet, Ducted outlet.
- Performance ratings do not include the effects of appurtenances (accessories).
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.
- Lp(A) at 3m free discharge dB(A) levels are not licensed by AMCA International.

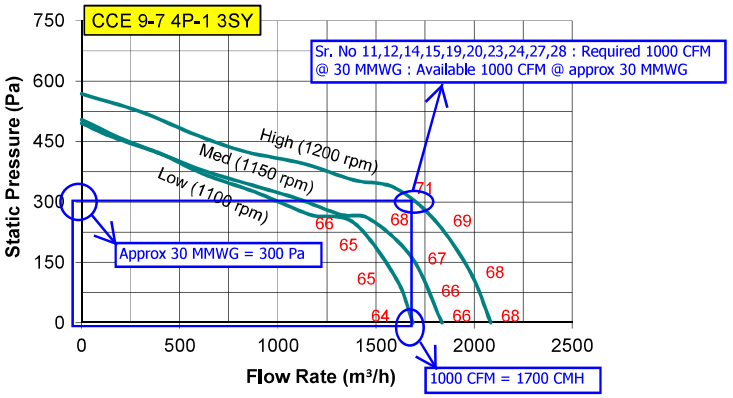




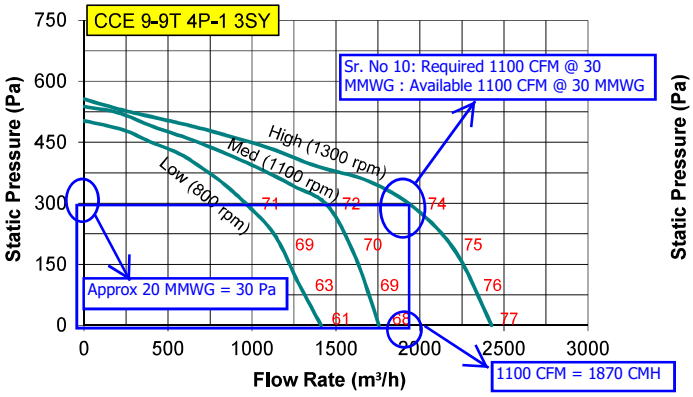


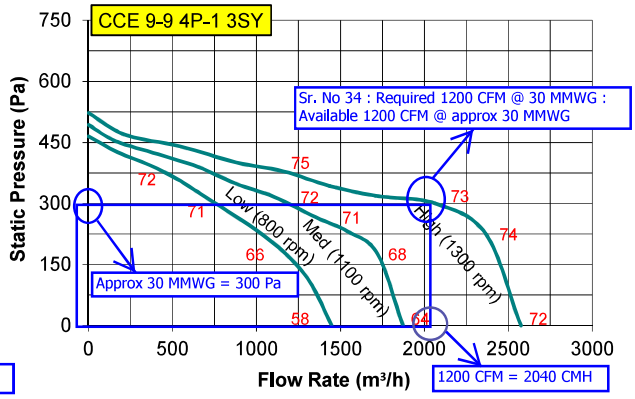


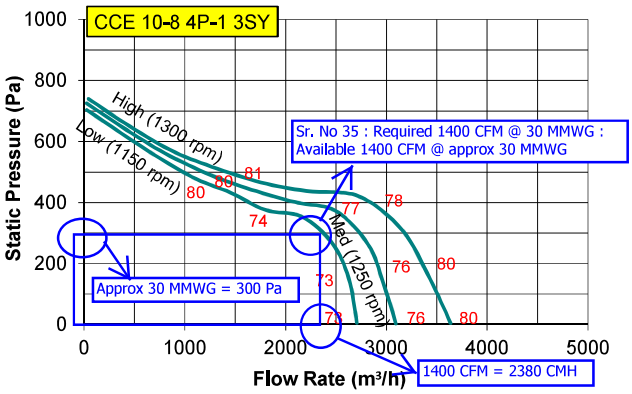


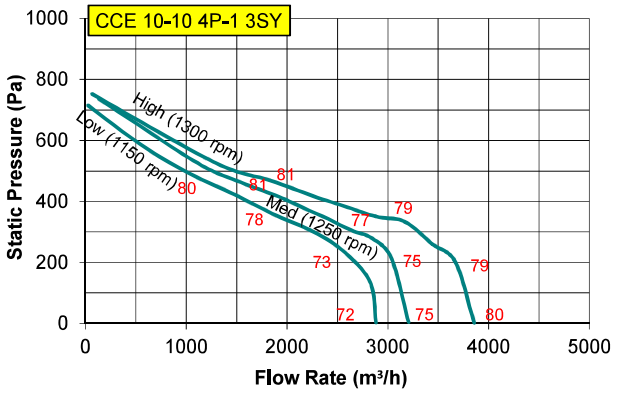


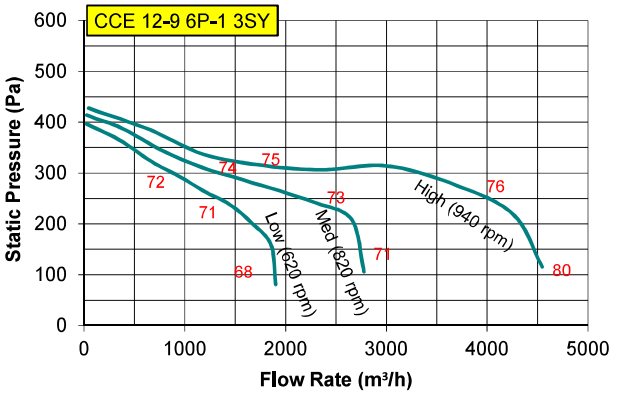
- Values shown are for inlet Lwi(A) sound power levels for installation type D – Ducted inlet, Ducted outlet. The A-weighted sound ratings shown have been calculated per AMCA International Standard 301. Ratings include the effects of duct end correction.
- Performance certified is for installation type D – Ducted inlet, Ducted outlet.
- Performance ratings do not include the effects of appurtenances (accessories).
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.

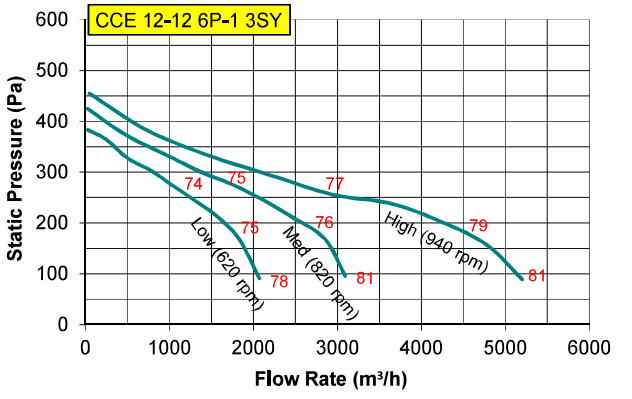










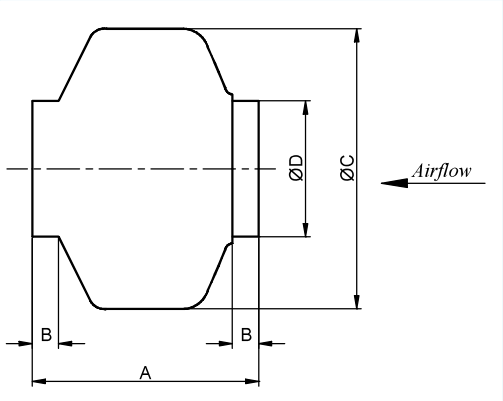


- Values shown are for inlet Lwi(A) sound power levels for installation type D – Ducted inlet, Ducted outlet. The A-weighted sound ratings shown have been calculated per AMCA International Standard 301. Ratings include the effects of duct end correction.
- Performance certified is for installation type D – Ducted inlet, Ducted outlet.
- Performance ratings do not include the effects of appurtenances (accessories).
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.

In-Line Centrifugal Duct Fan – TSK II Series

- *TSK II series are designed for direct in-line connection with industrial circular ducting of standard diameter.*
- *Suitable for applications in residential, commercial and industrial exhaust and supply ventilation such as bathrooms, kitchens, offices, factories, shops, bars, gymnasiums, restaurants etc.*
- *Complete range of inlet and outlet diameters to allow installations in most standard sizes of commercial ducts.*
- *The motor and impeller assembly are suitable for operation at any angle and deliver exceptional airflow performances against the high static pressures typically found in ducted ventilation systems.*
- *All TSK II series fan casing are manufactured from corrosion resistant pressed galvanised sheet steel.*
- *Non-stalling backward curved impeller which is factory matched to the corresponding external rotor motor and dynamically balanced to ISO 1940 standards for vibration free operation.*
- *All models are supplied as standard with a remotely mounted wiring junction box to provide the installer with a completely flexible choice for positioning and installation.*
- *Motors of this TSK II series are fully speed controllable using electronic or auto-transformer voltage control regulators.*
- *Enclosed, single phase, 230V, 50/60 Hz external rotor type, motors included sealed for life ball bearing assemblies and Class B, IP44 protection with an internal automatic reset safety thermal overload protection device as standard.*
- *Operating temperature - 40℃ to +40℃*

Dimensions



Model	A	B	ØC	ØD	Wt (kg)
TSK II 100L	194	23	243	98	3
TSK II 125L	195	27	243	123	3
TSK II 160L	222	28	333	157	5
TSK II 200L	223	25	333	198	5
TSK II 250L	206	27	333	248	6
TSK II 315L	230	25	401	312	8

Serial number 10

Kruger Ventilation Industries Pte Ltd certifies that the **TSK II series** shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA publication 211 and AMCA publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

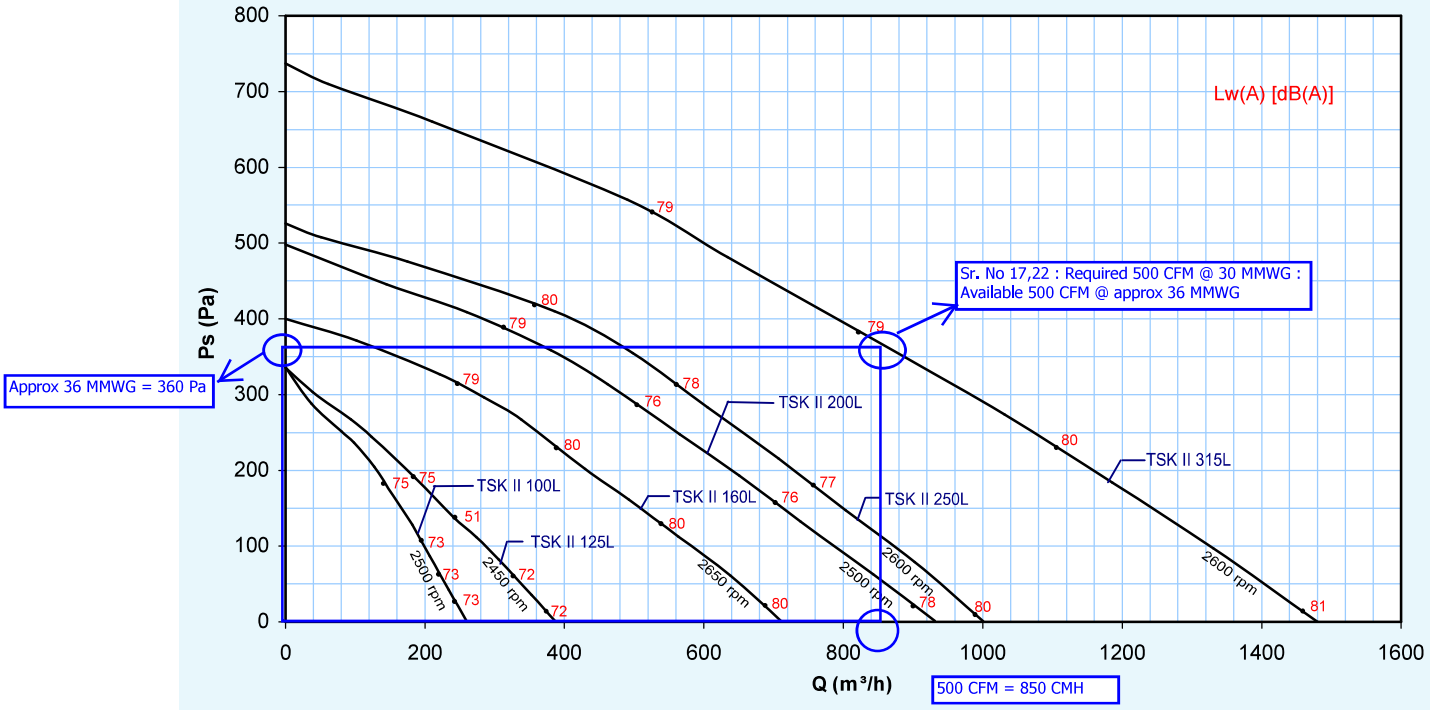
Technical Data

Model	Max Q m3/h	Max Input Power W	Motor Protection	Phase	N° Pole	Hz	Max Amp	Insulation Class	dB (A) at 3m	RPM
TSK II 100L	265/267	73/91	IP44	1	2	50/60	0.33/0.35	B	52/53	2500/2650
TSK II 125L	395/400	75/95	IP44	1	2	50/60	0.35/0.38	B	51/51	2450/2550
TSK II 160L	726/780	121/178	IP44	1	2	50/60	0.55/0.60	B	59/60	2650/2750
TSK II 200L	950/1045	141/201	IP44	1	2	50/60	0.72/0.80	B	57/58	2500/2700
TSK II 250L	1020/1125	140/212	IP44	1	2	50/60	0.80/0.82	B	59/61	2600/2800
TSK II 315L	1509/1688	240/352	IP44	1	2	50/60	1.45/1.50	B	60/63	2600/2750

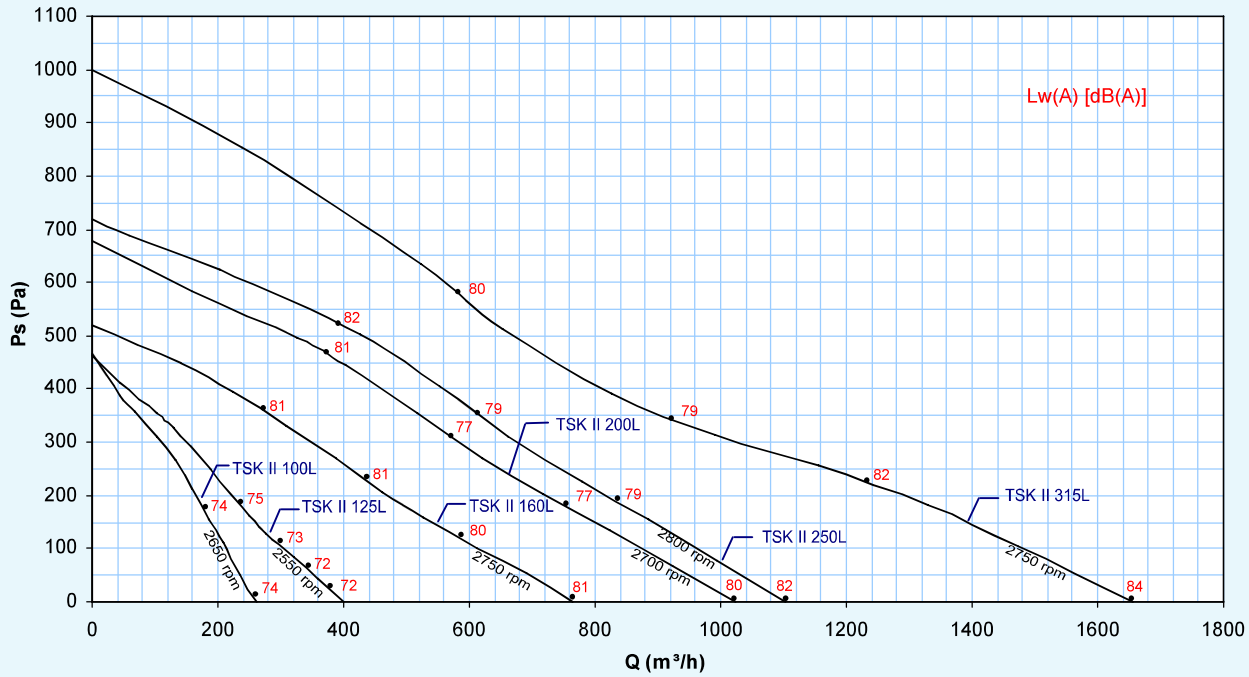
Serial number 17,22

- *Speed (RPM) shown is nominal. Performance is based on actual speed of test.*
- *Performance ratings do not include the effects of appurtenances (accessories).*
- *dB(A) at 3m with ducted inlet and outlet at free field conditions.*

Performance Data - 50Hz



Performance Data - 60Hz

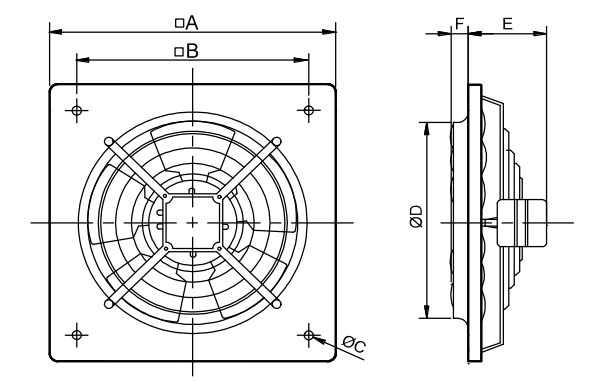


- *Speed (RPM) shown is nominal. Performance is based on actual speed of test.*
- *Performance ratings do not include the effects of appurtenances (accessories).*
- *The A-weighted sound ratings shown have been calculated per AMCA standard 301. Values shown are for inlet Lw(A) sound power levels for installation type D: ducted inlet, ducted outlet. Ratings include the effect of duct end correction.*

Plate Mounted Axial Flow Fans – **APM Series**

- *APM Series is designed for direct wall-mounting or panel-mounting.*
- *Suitable for ventilation application where the extraction of small volume of air at low pressure is required, eg. cafes, bars, small restaurants, commercial premises and small workshops.*
- *Complete with one piece bell mouth inlet and mounting plate manufactured from pressed galvanised steel with polyester painting finish.*
- *Fitted with steel finger-proof guard as standard mounted at the inlet side of fan.*
- *5-bladed impeller manufactured from aluminium finished with epoxy-polyester painting.*
- *Incorporates single phase shaded pole asynchronous induction motor and an auto reset thermal overload protection device.*
- *Supplied with a cable for connection to electrical supply.*
- *Max. operating temperature: APM 200-355: +40 ℃*

Dimension



Model	□A	□B	ØC	ØD	E	F	Wt (kg)
APM 200	266	222	9	205	88	19	1.8
APM 250	333	275.5	9	255	99	31	2.2
APM 315	400	336.5	10.5	305	99	35.5	3.2
APM 355	465	390	10.5	361	106	34.5	4.3

All Dimensions in mm

Sr. No 18,26,31,33

Technical Data

Sr. No 18,26,31,33 : Required 150 & 200 CFM : Available 295 CFM at Free Flow.

Model	Max Q m³/h	Power W	Motor Protection	Motor	N° Pole	Hz	Max Amp	Volt	Insulation Class	dB (A) at 3m	RPM
APM 200	500	18	IP44	1 Phase	4	50	0.08	230	B	36	1300
APM 250	900	22	IP44	1 Phase	4	50	0.10	230	B	42	1300
APM 315	1400	30	IP44	1 Phase	4	50	0.15	230	B	48	1300
APM 355	1800	40	IP44	1 Phase	4	50	0.17	230	B	53	1300

** dB(A) at 3m measured at free discharge.*

Propeller Fans – APL Series

- Propeller fan for wall or panel mounting suitable for supply or exhaust use.
- Sickle Blade impellers, installed with the external rotor motors.
- Wall plate is made of high grade steel sheet with painted finish, galvanized steel sheet wall plate can be supplied upon request.
- Fan impellers are statically and dynamically balanced to ISO 1940 standard.
- Low noise level with high efficiency.
- Accessories such as speed controller and mounting accessories can be supplied upon request.
- Model APL 710-1000 are not licensed by AMCA International.

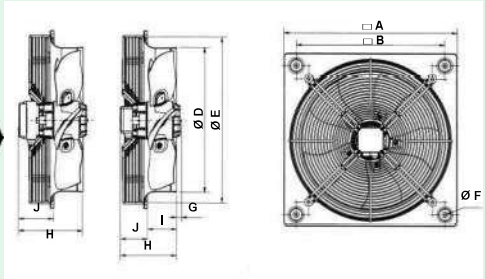
Kruger Ventilation Industries Asia Co., Ltd certifies that the model APL 315-630 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program. Model APL 710-1000 are not licensed by AMCA International.

Dimension

315 - 710

Sr. No 16,21,25,29,32

1 PHASE 3 PHASE



Model	□A	□B	ØD	ØE	ØF	G	H	I	J	Wt (kg)
APL 315 4P-1 1S	400	330	315	329	10	-	149	68	82	7.0
APL 355 4P-1 1S	450	380	355	371	10	-	156	75	82	7.5
APL 400 4P-1 1S	500	420	400	422	10	12	200	78	122	9.0
APL 450 4P-1 1S	560	480	450	476	10	-	204	91	114	11.5
APL 500 4P-1 1S	630	560	500	536	10	13	201	97	104	16.0
APL 500 6P-1 1S	630	560	500	536	10	-	201	97	104	16.0
APL 560 4P-1 1S	710	630	560	596	10	20	213	99	114	21.5
APL 560 6P-1 1S	710	630	560	596	10	2	213	99	114	21.5
APL 560 6P-3 1S	710	630	560	596	10	-	188	99	89	21.5
APL 630 4P-3 1S	800	710	630	674	12	25	182	103	79	24.0
APL 630 6P-3 1S	800	710	630	674	12	7	182	103	79	24.0
APL 710 6P-3 1S	900	800	710	733	12	11	206	92	115	27.0

Sr. No 13

Technical Data - 50Hz

Sr. No 16,21,25,29,32 : Required 1000 CFM : Available 1100 CFM at Free Flow

Sr. No 13 : Required 2000 CFM : Available 2820 CFM at Free Flow

Model	Max Q (m³/h)	Maximum Motor Input Power (W)	Motor Protection	Motor	N° Pole	Hz	Maximum Current (A)		Insulation Class	Lp (A)at 3m free discharge (dB (A))*	Speed (RPM)
							220V	400V			
APL 315 4P-1 1S	1886	112	IP54	Single Phase	4	50	0.60	-	F	46	1420
APL 355 4P-1 1S	2632	145	IP54	Single Phase	4	50	0.70	-	F	48	1345
APL 400 4P-1 1S	4792	268	IP54	Single Phase	4	50	1.20	-	F	52	1355
APL 450 4P-1 1S	6574	457	IP54	Single Phase	4	50	2.00	-	F	55	1325
APL 500 4P-1 1S	8183	867	IP54	Single Phase	4	50	3.60	-	F	56	1390
APL 500 6P-1 1S	5335	228	IP54	Single Phase	6	50	1.10	-	F	44	875
APL 560 4P-1 1S	10577	1084	IP54	Single Phase	4	50	4.60	-	F	57	1370
APL 560 6P-1 1S	6959	371	IP54	Single Phase	6	50	1.71	-	F	48	910
APL 560 6P-3 1S	7718	405	IP54	Three Phase	6	50	-	0.90	F	50	940
APL 630 4P-3 1S	12640	1066	IP54	Three Phase	4	50	-	2.20	F	61	1380
APL 630 6P-3 1S	10317	607	IP54	Three Phase	6	50	-	1.10	F	54	900
APL 710 6P-3 1S	15055	1019	IP54	Three Phase	6	50	-	2.20	F	57	910

* Inlet Lp(A) sound pressure levels at 3m are measured at free discharge in spherical free field condition, inlet Lp(A) (dB(A)) levels are not licensed by AMCA International.

- Performance ratings do not include the effects of appurtenances (accessories).
- Performance certified is for installation type A - Free inlet, Free outlet.
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.
- Model APL 710 is not licensed by AMCA International.

Havells India Ltd.
Neemrana, Distt. Alwar (Raj)

HAVELLS

HSD2FS401X5

Date - 10.08.2022 Rev - 02

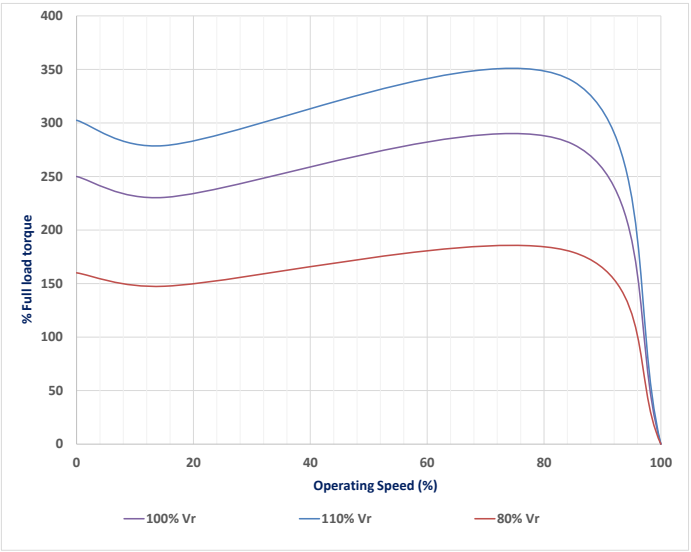
MOTOR DATA SHEET

SR NO.	DESCRIPTION	UNIT	
1	Make		Havells India Ltd.
2	Type of motor		AC 3 PH. Sq. Cage Induction Motor
3	Efficiency Class		IE2
4	Frame size		MHEE90LBA4
5	Ambient	Deg C	50
6	Nominal output	kW/HP	1.5/2.0
7	Duty		S1
8	Pole / Rated Speed (RPM)		4/1420
9	Insulation Class		F
10	Temperature Rise		Limited to Class B
11	Mounting arrangement		B3
12	T.B. Position (Viewed from DE side)		TOP
13	Voltage	Volts	415± 10%
14	Rated Frequency	Hz	50 ± 5%
15	Allowable combined variation		± 10%
16	Type of connection		Star(Y)
17	Full load current	Amps.	3.6
18	Efficiency at rated Voltage at 100% load	%	82.8
19	Efficiency at rated Voltage at 75% load	%	82.8
20	Efficiency at rated Voltage at 50% load	%	81.2
21	Power factor at rated Voltage		0.70
22	Starting torque at rated Voltage	%	250
23	Pull-out torque at rated Voltage	%	280
24	Starting current at rated Voltage	%	600
25	Construction / Method of cooling		TEFC / IC411
26	Degree of protection of enclosure		IP 55
27	Paint Shade		Smoke Grey
28	Type of bearing DE/NDE		6205 2Z/6205 2Z
29	Grease Type		Lithium Base, Grade-3
30	Cable Entry		1xM25x1.5+1xM20x1.5
31	Motor GD²	kgm²	0.022
32	Net weight	kg	26.5
33	Applicable standard		IS 12615

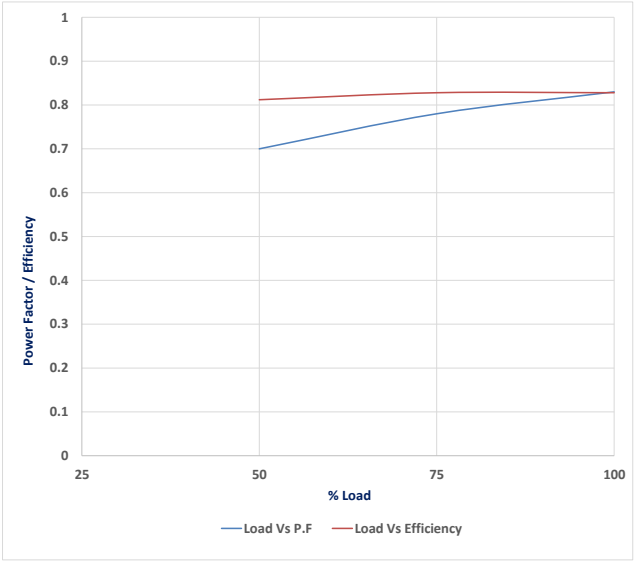
Note:- All Performance figures are subject to tolerance as per IS 12615.

Customer Name	:							
Application	:							
TDS Number	:							
Rating	:	1.5	kW	**Starting Time without Load/With Load**	:	0.12 | 0.4	sec	
Pole	:	4		**J Motor(Kgm2)**	:	0.02		
Frame Size	:	MHEE90LBA4		**Withstand Time(HOT/COLD)**	:	16 | 29	sec	

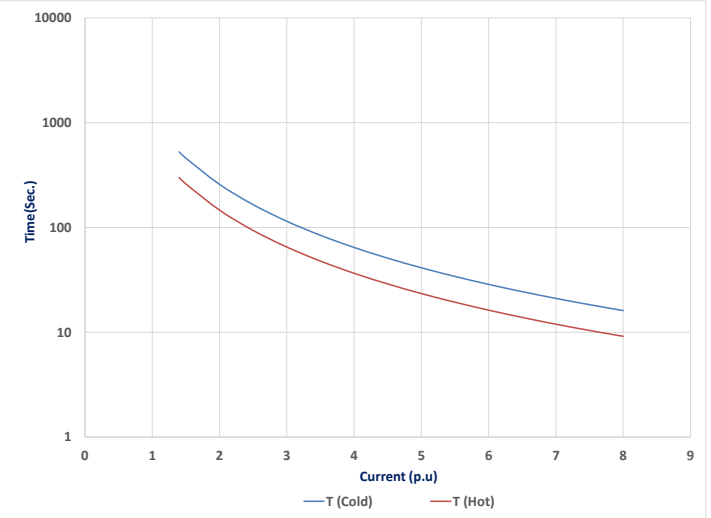
Torque Vs Speed



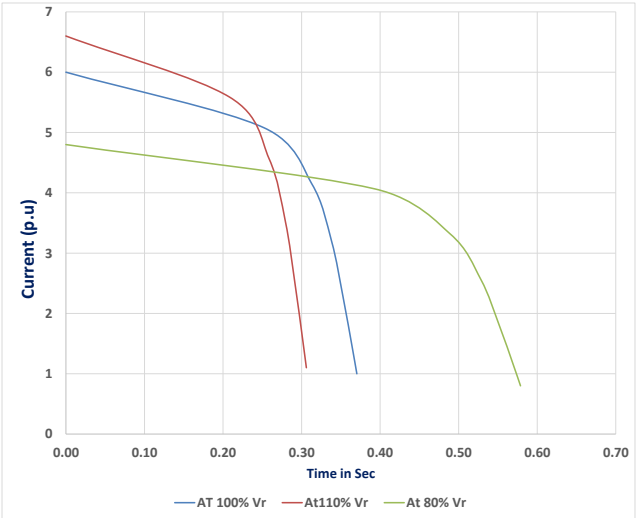
Load Vs Efficiency & Power Factor



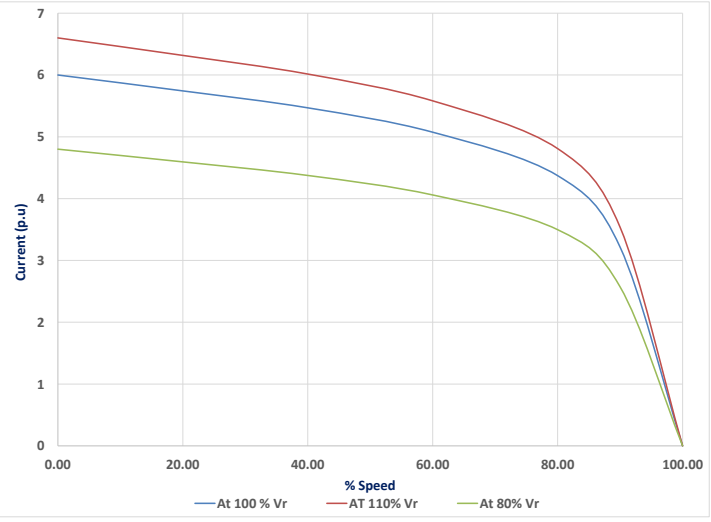
Thermal Withstand Time



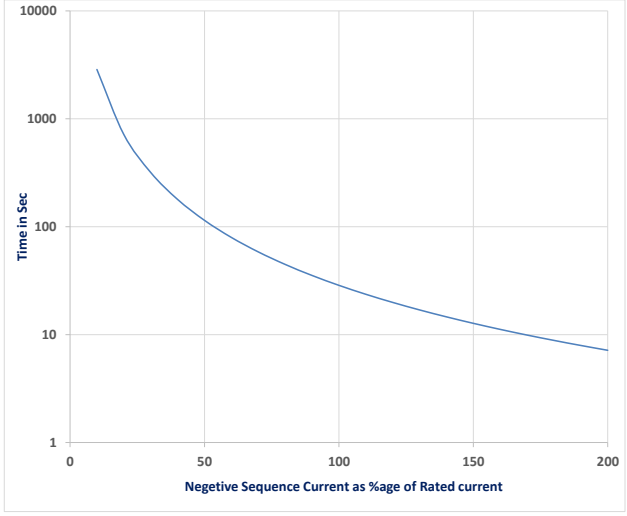
Current Vs Time



Current Vs Speed



Negetive Sequence Current



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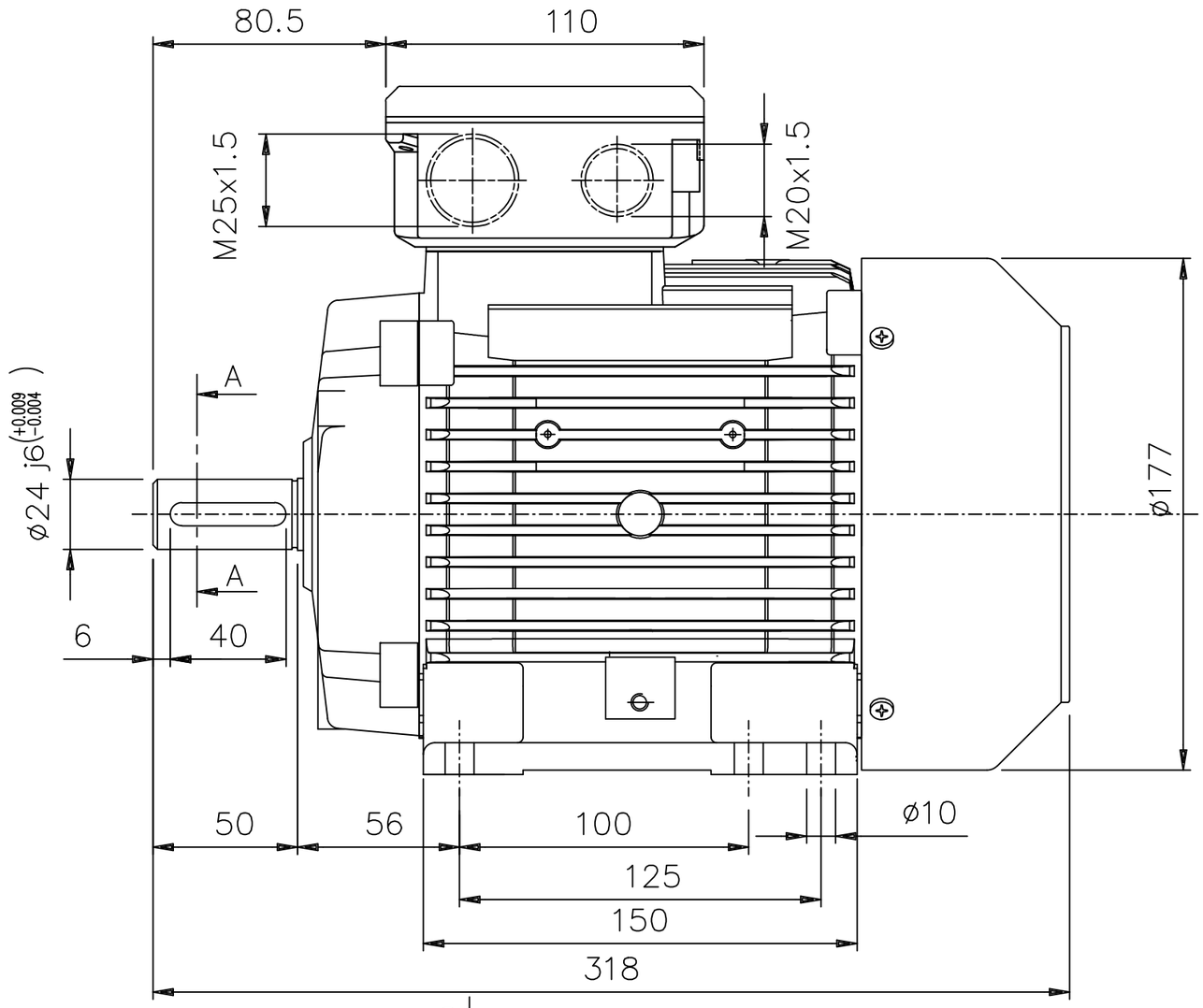
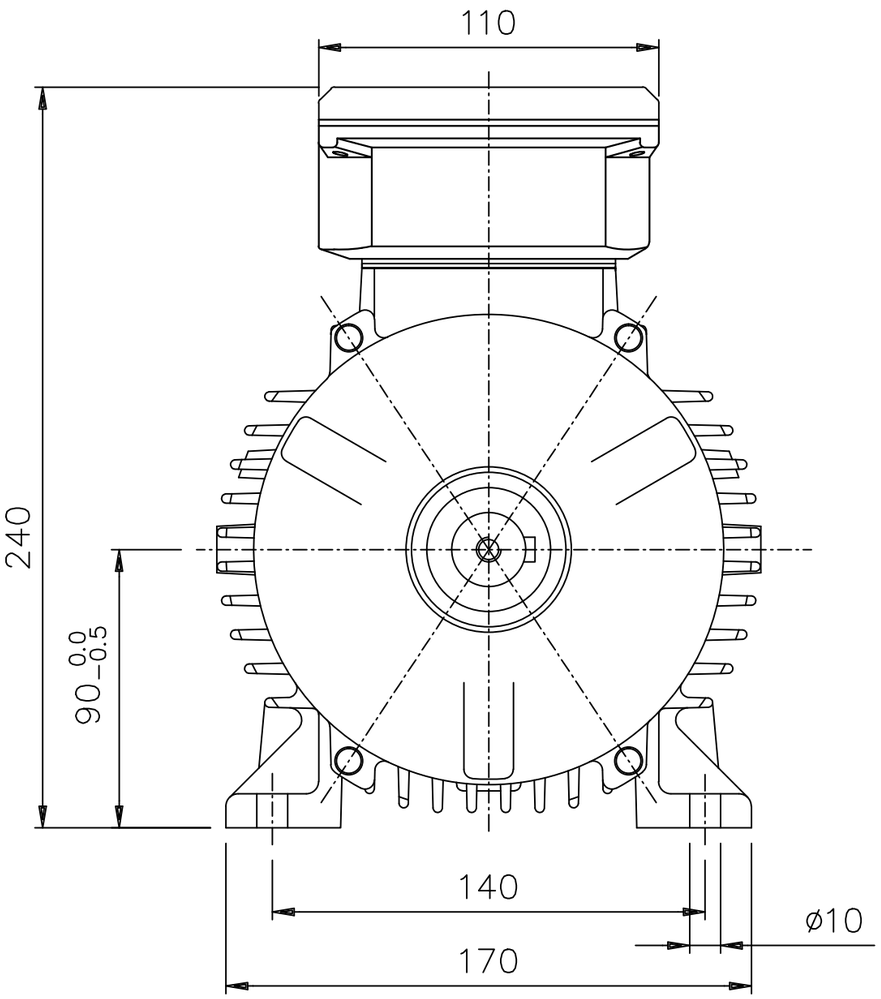
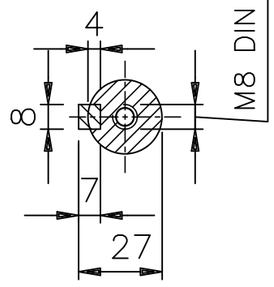


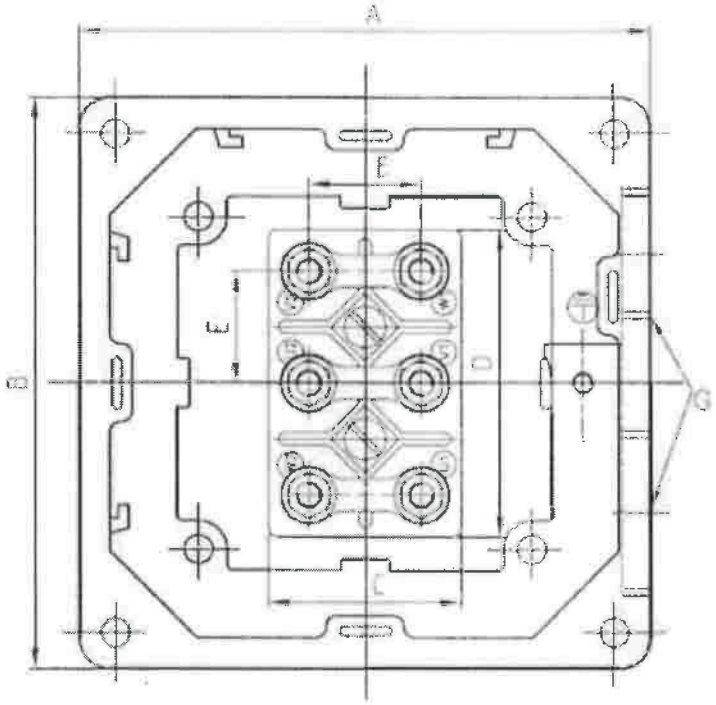


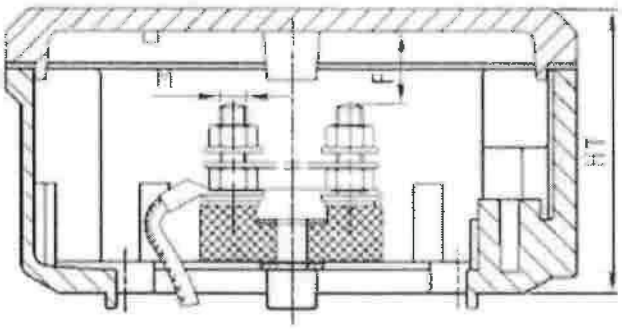


SECTION A–A

CAD DRAWING NO MANUAL ALTERATION				
Roughness Ra in accordance to UNI 3963	GEN MOTOR DIMS 90S-L B3		CAST IRON	
	DESCRIPTION		MATERIAL	WEIGHT
Unspecified Radii assumed as 0.5mm Unspecified Drafts, Angles assumed as 1° All Dimensions are in mm	REF.	FRAME 90S-L	DRAWING No. HM_TEMP_0426	
General Tolerances according to ISO2768-mK / EN 22768-1/2	CODE –	CLIENT –	DRAWN GAURAV	REVISION 00
HAVELLS INDIA LTD.		SCALE 1:1.5 – FORMAT A2	CHECKED KKG / APPROVED KKG	DATE 30/07/12

HM_TBA_1433





FRAME	A	B	C	D	E	F	G	HT	M
80	111	116	25	40	15	20	M20 , M25	55	M4
90	111	116	36	56	20	20	M20 , M25	55	M5
100	111	116	36	56	20	20	M20 , M25	55	M5
112	111	116	36	56	20	20	M20 , M25	55	M5

NOTE:

1. ALL DIMENSION ARE IN MM.
2. DEGREE OF PROTECTION IP 55

CAD DRAWING
NO MANUAL ALTERATION

Roughness Ra in accordance to uni 3963	TERMINAL BOX ASSEMBLY	ALUMINIUM	
	DESCRIPTION	MATERIAL	WEIGHT
Unspecified Radii assumed as 0.5mm Unspecified drafts,Angles assumed as 1° All Dimensions are in mm	REF. / FRAME 80-112	DRAWING NO. HM_TBA_1433	
General Tolerances according to ISO2768-mK / EN 22768-1/2	CODE / CLIENT	DRAWN BY PANKAJ	REVISION 00
HAVELLS INDIA LTD.	SCALE 1:1 / FORMAT A3	CHECKED BY KKG APPROVED BY KKG	DATE 4/4/2012

Havells India Ltd.
Neemrana, Distt. Alwar (Raj)

HAVELLS

Date - 19.08.2021

HSD2GS402X2
Rev - 01

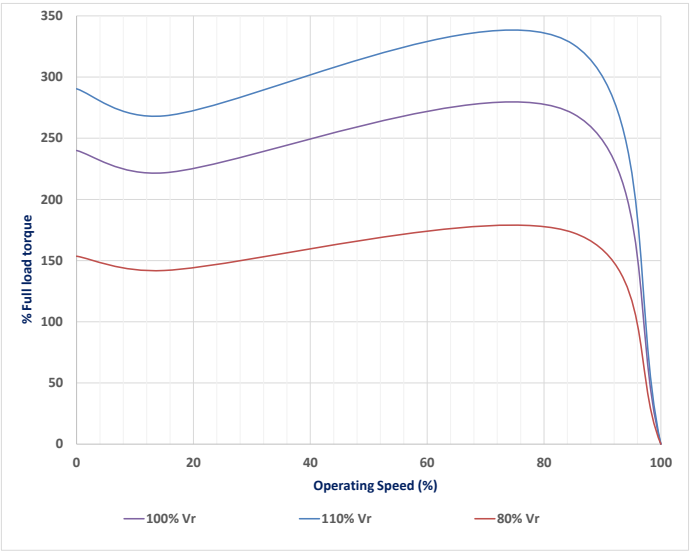
MOTOR DATA SHEET

SR NO.	DESCRIPTION	UNIT	
1	Make		Havells India Ltd.
2	Type of motor		AC 3 PH. Sq. Cage Induction Motor
3	Efficiency Class		IE2
4	Frame size		MHEE100LAA4
5	Ambient	Deg C	50
6	Nominal output	kW/HP	2.2/3.0
7	Duty		S1
8	Pole / Rated Speed (RPM)		4/1450
9	Insulation Class		F
10	Temperature Rise		Limited to Class B
11	Mounting arrangement		B3
12	T.B. Position (Viewed from DE side)		TOP
13	Voltage	Volts	415± 10%
14	Rated Frequency	Hz	50 ± 5%
15	Allowable combined variation		± 10%
16	Type of connection		Delta(Δ)
17	Full load current	Amps.	4.7
18	Efficiency at rated Voltage at 100% load	%	84.3
19	Efficiency at rated Voltage at 75% load	%	84.3
20	Efficiency at rated Voltage at 50% load	%	82.8
21	Power factor at rated Voltage		0.78
22	Starting torque at rated Voltage	%	240
23	Pull-out torque at rated Voltage	%	270
24	Starting current at rated Voltage	%	600
25	Construction / Method of cooling		TEFC / IC411
26	Degree of protection of enclosure		IP 55
27	Paint Shade		Smoke Grey
28	Type of bearing DE/NDE		6206 2Z/6206 2Z
29	Grease Type		Lithium Base, Grade-3
30	Cable Entry		1xM25x1.5+1xM20x1.5
31	Motor GD²	kgm²	0.0352
32	Net weight	kg	32
33	Applicable standard		IS 12615

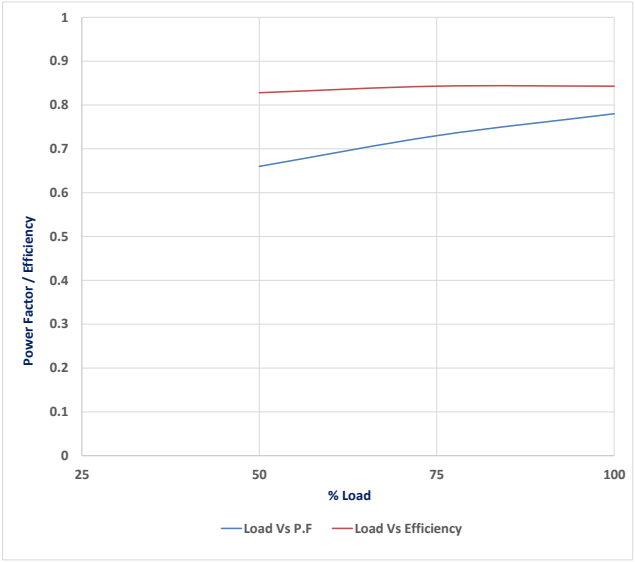
Note:- All Performance figures are subject to tolerance as per IS 12615.

Customer Name	:							
Application	:							
TDS Number	:							
Rating	:	2.2	kW	**Starting Time without Load/With Load**	:	0.14 | 0.4	sec	
Pole	:	4		**J Motor(Kgm2)**	:	0.04		
Frame Size	:	MHEE100LAA4		**Withstand Time(HOT/COLD)**	:	13 | 23	sec	

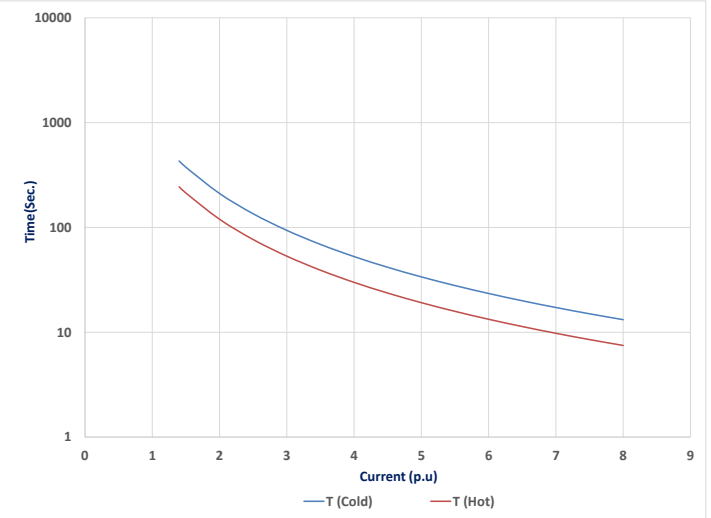
Torque Vs Speed



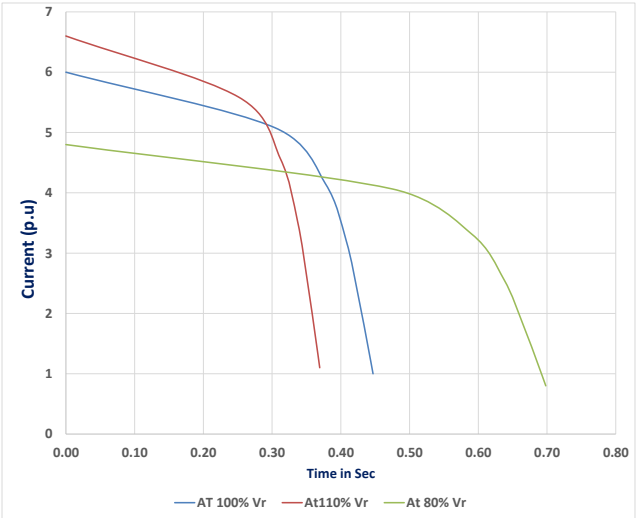
Load Vs Efficiency & Power Factor



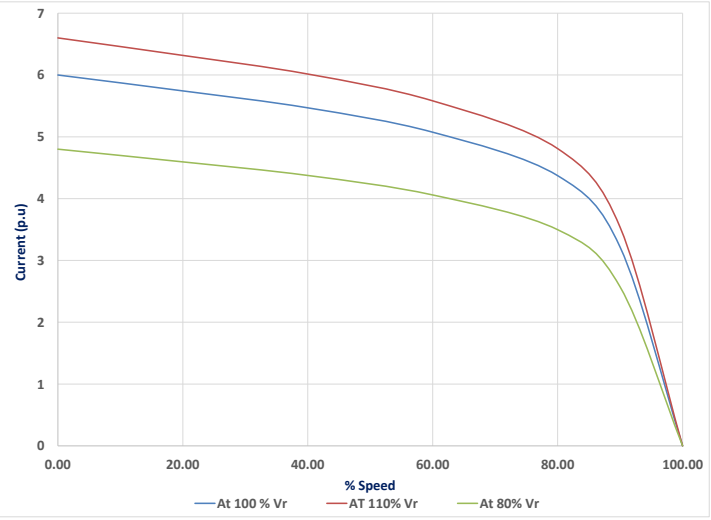
Thermal Withstand Time



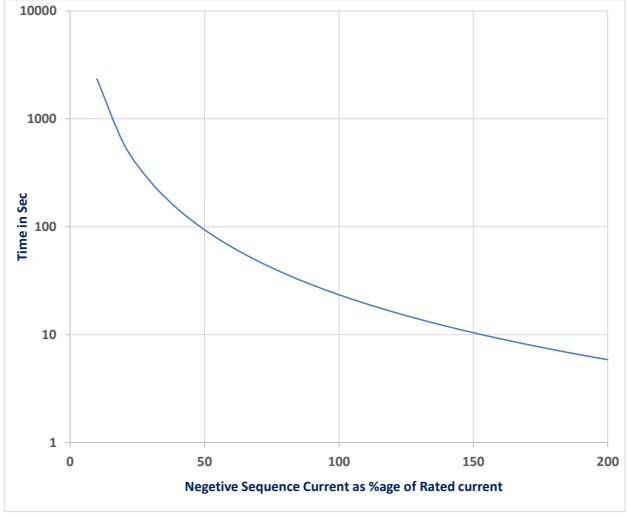
Current Vs Time



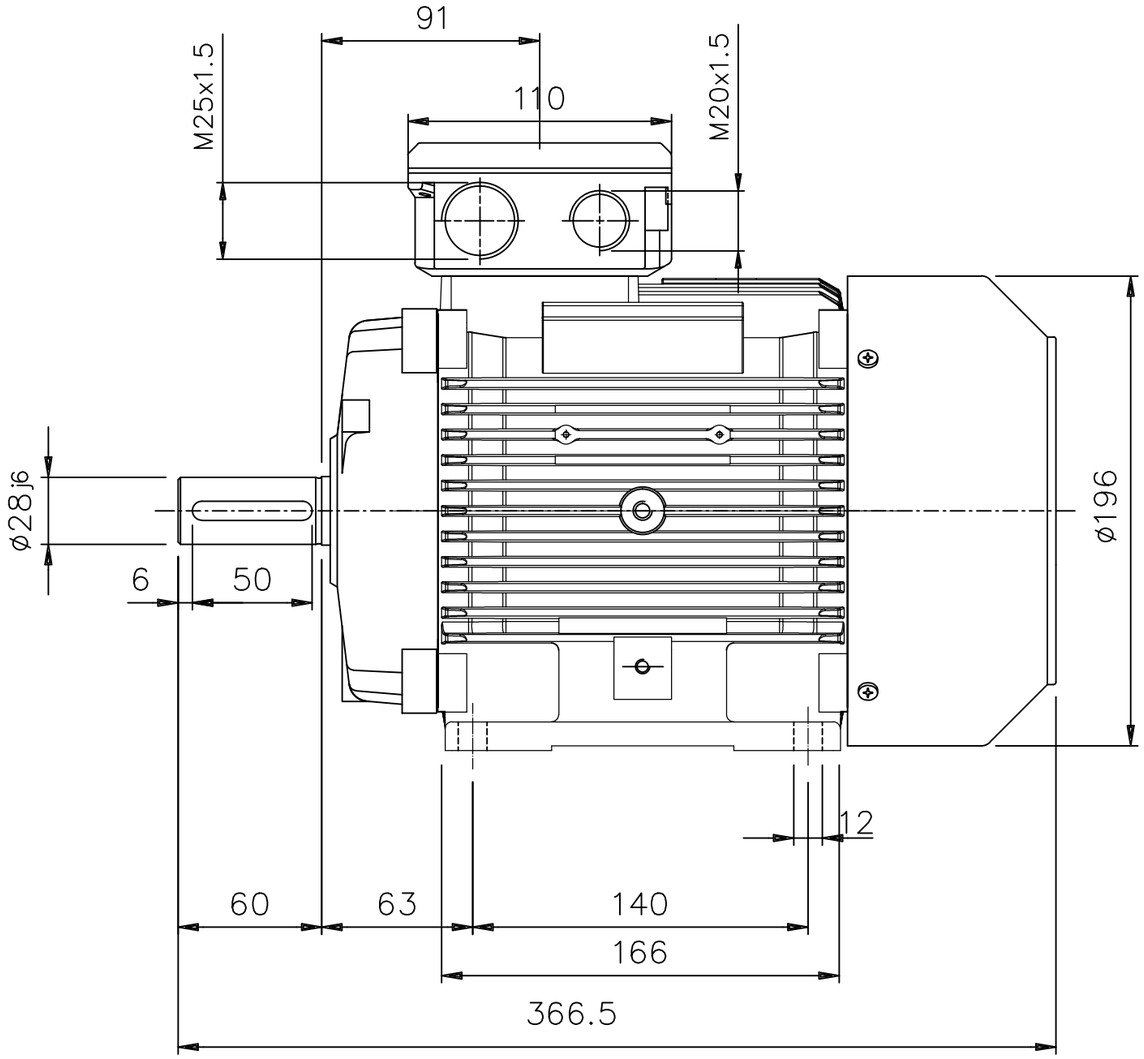
Current Vs Speed

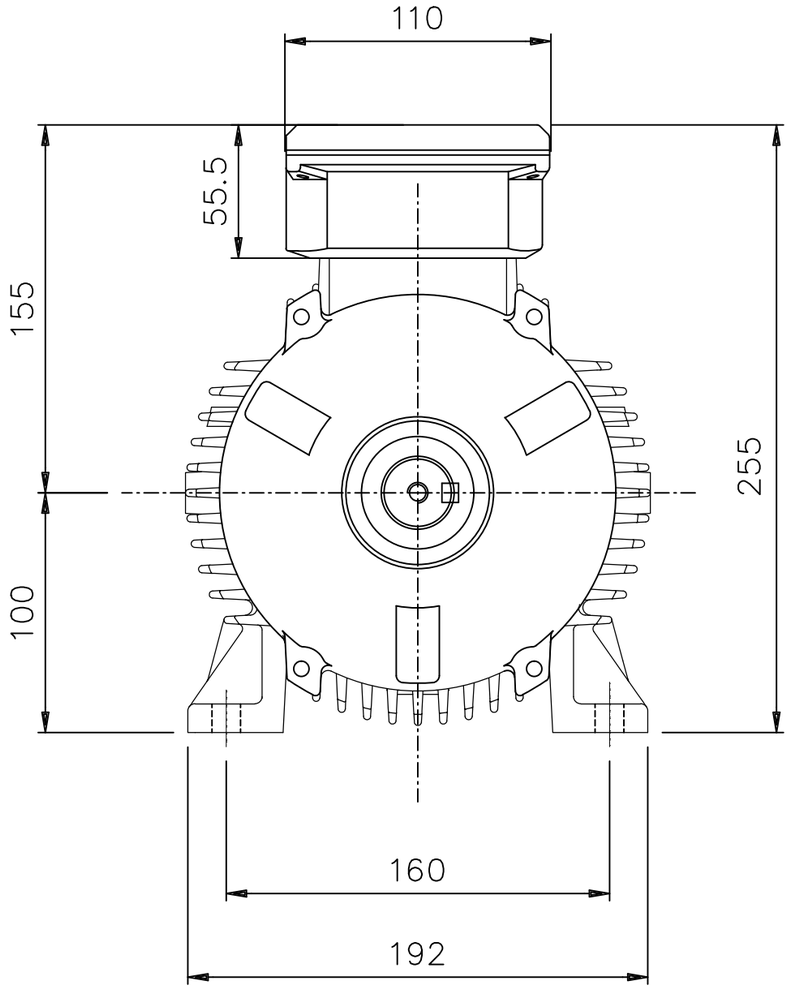


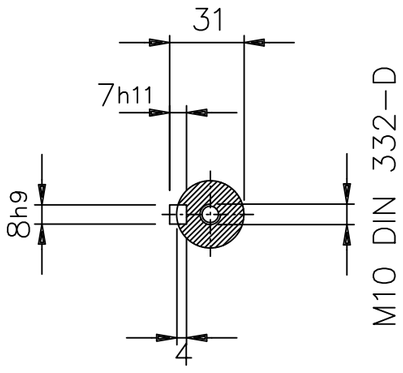
Negetive Sequence Current



HM_TEMP_0428







Nr.	Data	Revisione	Nome
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		--	

CAD DRAWING
NO MANUAL ALTERATION

Roughness Ra in accordance to UNI 3963 (12.5 / 3.2 / 0.8)

Unspecified Radii assumed as 0.5mm
Unspecified Drafts, Angles assumed as 1°
All Dimensions are in mm

General Tolerances according to ISO2768-mK / EN 22768-1/2

DESCRIPTION	MATERIAL	WEIGHT
GA–DRG MOTOR 100 FR B3 CI BODY	–	

REF.	FRAME	DRAWING No.
–	100 FRAME	HM_TEMP_0428

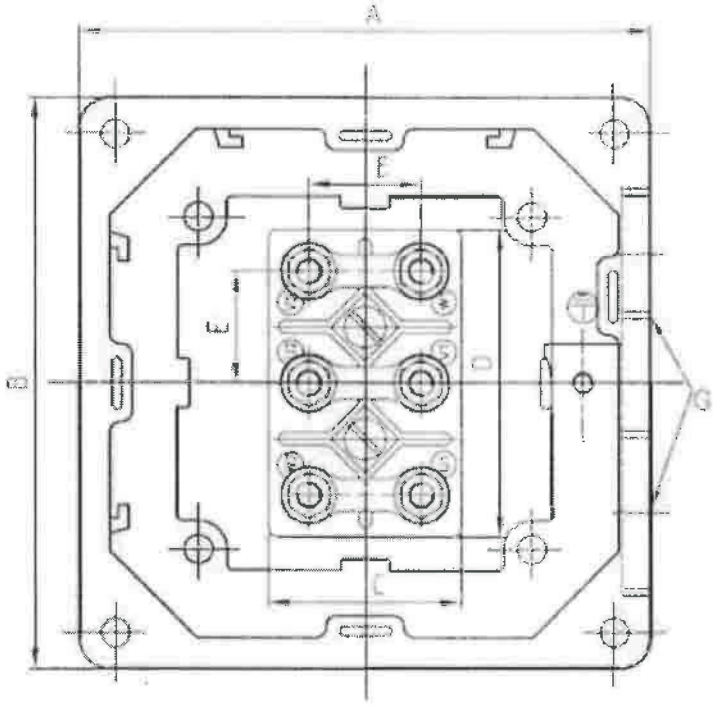
CODE	CLIENT	DRAWN	REVISION
	–	GAURAV	00

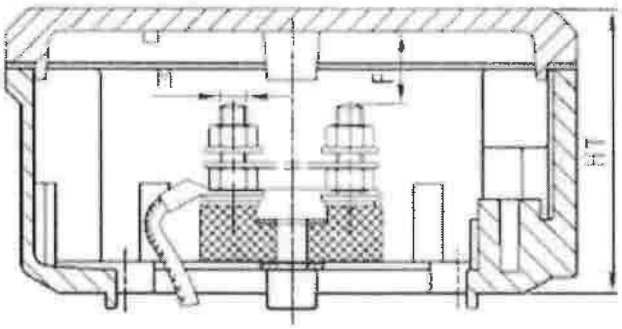
HAVELLS INDIA LTD.

SCALE	FORMAT	CHECKED	DATE
1:2 –	A2	KKG	31/07/2012

APPROVED KKG

HM_TBA_1433





FRAME	A	B	C	D	E	F	G	HT	M
80	111	116	25	40	15	20	M20 , M25	55	M4
90	111	116	36	56	20	20	M20 , M25	55	M5
100	111	116	36	56	20	20	M20 , M25	55	M5
112	111	116	36	56	20	20	M20 , M25	55	M5

NOTE:

1. ALL DIMENSION ARE IN MM.
2. DEGREE OF PROTECTION IP 55

CAD DRAWING
NO MANUAL ALTERATION

Roughness Ra in accordance to uni 3963	TERMINAL BOX ASSEMBLY	ALUMINIUM	
	DESCRIPTION	MATERIAL	WEIGHT
Unspecified Radii assumed as 0.5mm Unspecified drafts,Angles assumed as 1° All Dimensions are in mm	REF. / FRAME 80-112	DRAWING NO. HM_TBA_1433	
General Tolerances according to ISO2768-mK / EN 22768-1/2	CODE / CLIENT	DRAWN BY PANKAJ	REVISION 00
HAVELLS INDIA LTD.	SCALE 1:1 / FORMAT A3	CHECKED BY KKG APPROVED BY KKG	DATE 4/4/2012

Havells India Ltd.
Neemrana, Distt. Alwar (Raj)

HS25D2KS607X5

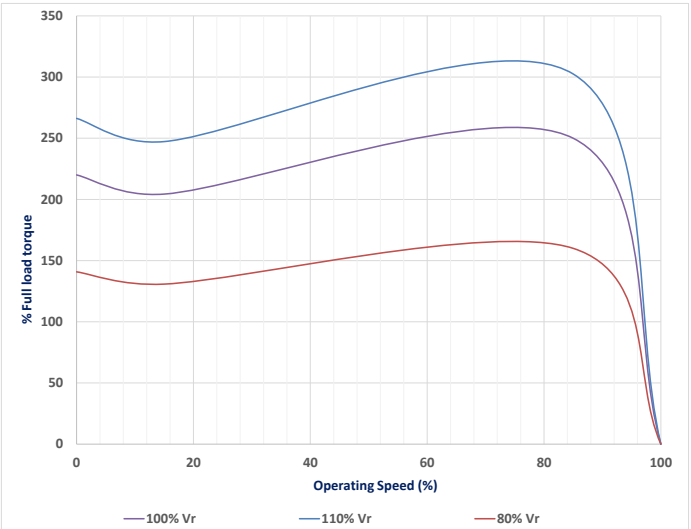
MOTOR DATA SHEET

SR NO.	DESCRIPTION	UNIT	
1	Make		Havells India Ltd.
2	Type of motor		AC 3 PH. Sq. Cage Induction Motor
3	Efficiency Class		IE2
4	Frame size		MHEE160MZA6
5	Ambient	Deg C	50-250 ºC / 2 HRS
6	Nominal output	kW/HP	7.5/10
7	Duty		S1-S2
8	Pole / Rated Speed (RPM)		6/970
9	Insulation Class		H(Smoke)
10	Temperature Rise		Limited to Class B
11	Mounting arrangement		B3
12	T.B. Position (Viewed from DE side)		TOP
13	Cable Gland Material		Metallic
14	Fly Lead Length / Material		1 meter / Fire Retarded
15	Voltage	Volts	415± 10%
16	Rated Frequency	Hz	50 ± 5%
17	Allowable combined variation		± 10%
18	Type of connection		Delta(Δ)
19	Full load current	Amps.	15.5
20	Efficiency at rated Voltage at 100% load	%	87.2
21	Efficiency at rated Voltage at 75% load	%	87.2
22	Efficiency at rated Voltage at 50% load	%	86.3
23	Power factor at rated Voltage		0.77
24	Starting torque at rated Voltage	%	220
25	Pull-out torque at rated Voltage	%	250
26	Starting current at rated Voltage	%	650
27	Construction / Method of cooling		TEAO / IC418
28	Degree of protection of enclosure		IP 55
29	Paint Shade		Smoke Grey
30	Type of bearing DE/NDE		6309 Z/6209 Z
31	Grease Type		High Temperature Grease
32	Cable Entry		2xM40x1.5
33	Motor GD²	kgm²	0.354
34	Approx Net weight	kg	106
35	Applicable standard		IS/IEC 60034-1 & EN 12101-3

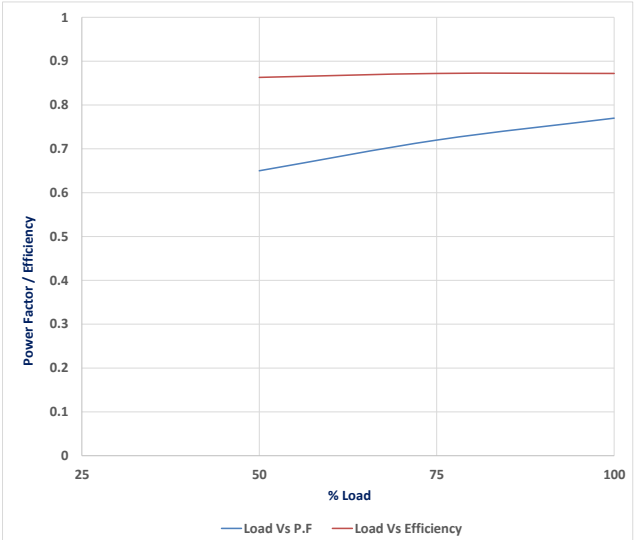
Note:- All Performance figures are subject to tolerance as per IS/IEC.

Customer Name	:							
Application	:							
TDS Number	:							
Rating	:	7.5	kW	**Starting Time without Load/With Load**	:	0.21 | 0.7	sec	
Pole	:	6		**J Motor(Kgm2)**	:	0.35		
Frame Size	:	MHEE160MZA6		**Withstand Time(HOT/COLD)**	:	17 | 29	sec	

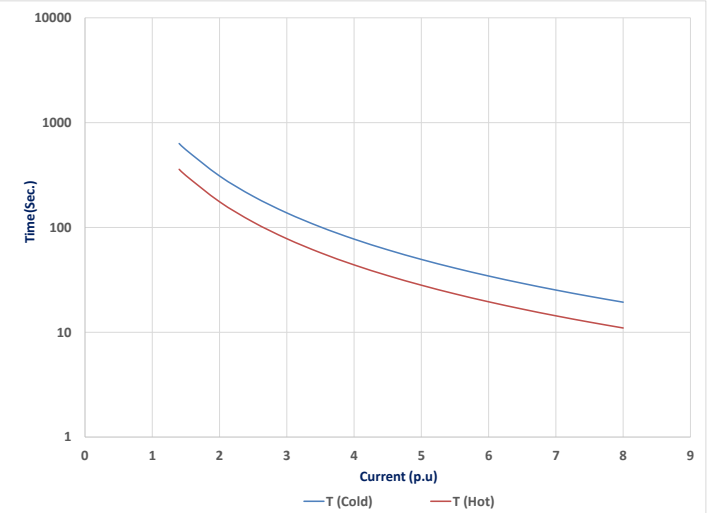
Torque Vs Speed



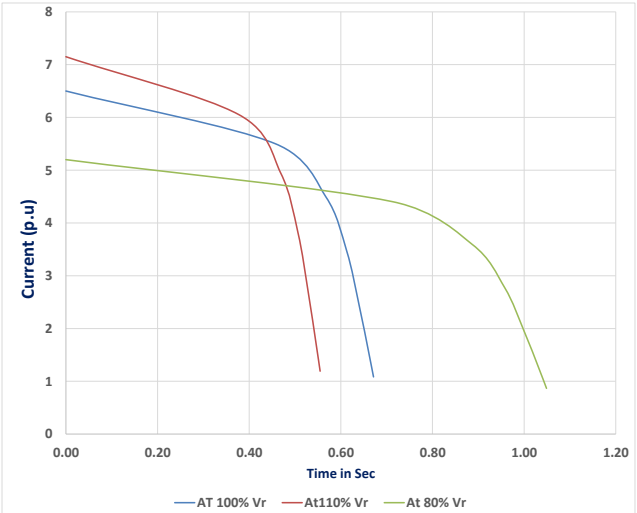
Load Vs Efficiency & Power Factor



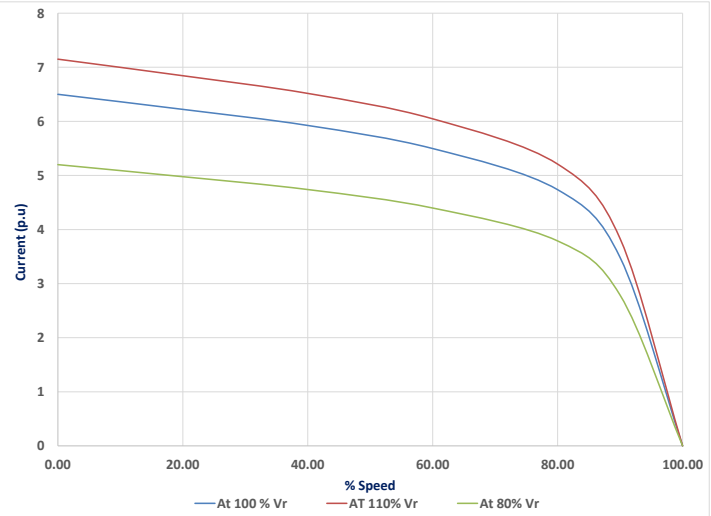
Thermal Withstand Time



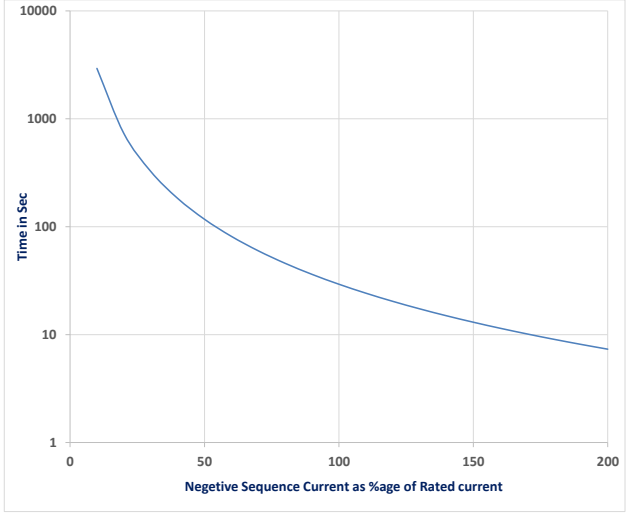
Current Vs Time



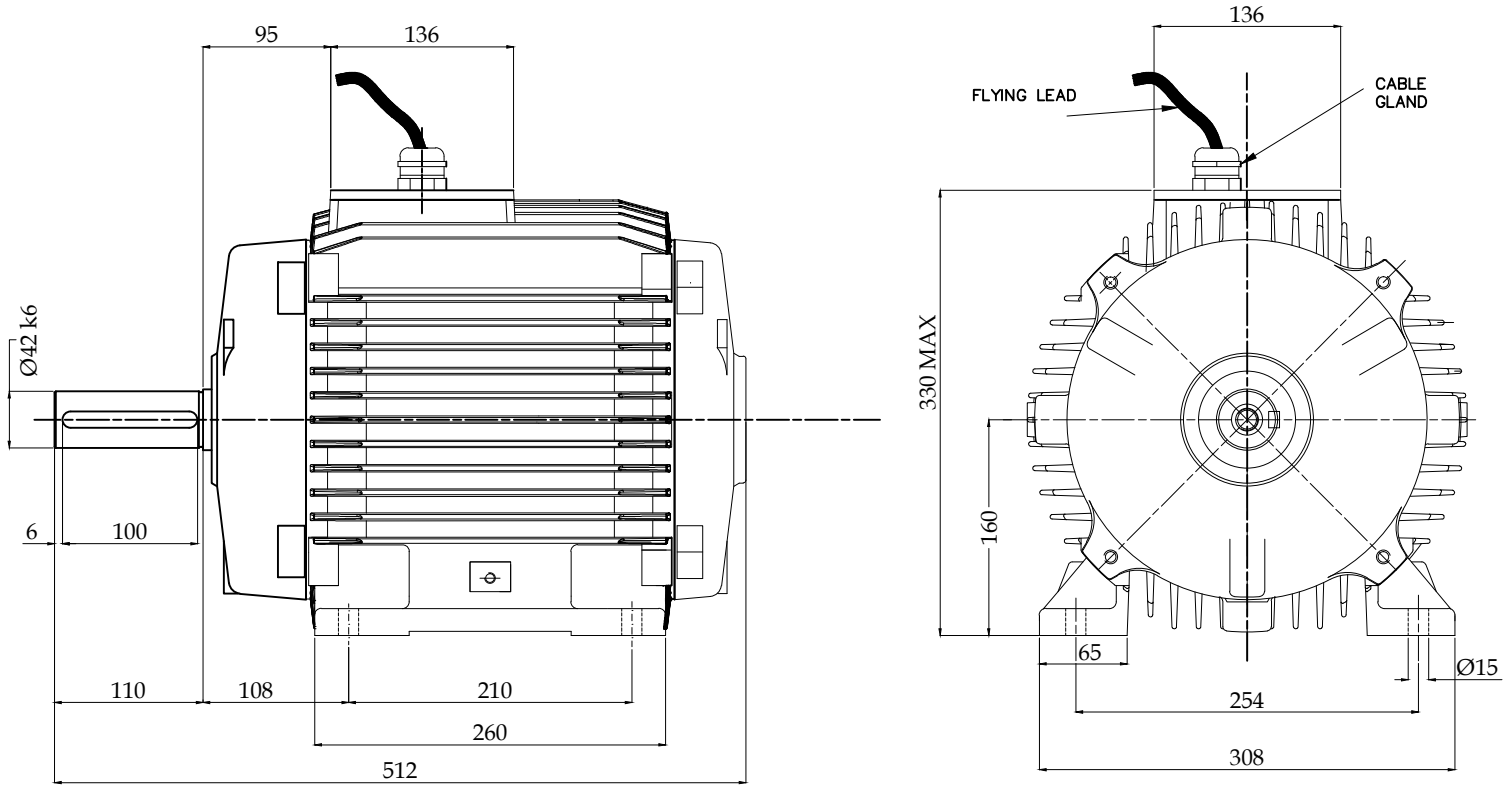
Current Vs Speed

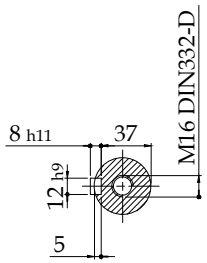


Negetive Sequence Current



HM_TEMP_1410





Nr.	Data	Revisione	Nome
01	05-09-17	CABLE GLAND POSITION REVISED	VIKAS
	-	-	

CAD DRAWING
NO MANUAL ALTERATION

Roughness Ra in accordance to UNI 3963

Unspecified Radii assumed as 0.5mm
Unspecified Drafts, Angles assumed as 1°
All Dimensions are in mm

General Tolerances according to ISO2768-mK / EN 22768-1/2

DESCRIPTION	G.A.DWG. 160M FRAME B3 TE + FLR			MATERIAL	CAST IRON BODY MOTOR
REF.		FRAME	160M FRAME	DRAWING No.	HM_TEMP_1410
CODE		CLIENT		DRAWN	VG
		SCALE	1:5	FORMAT	A3
				CHECKED	KKG
				APPROVED	KKG
				REVISION	00
				DATE	05-04-2017

HAVELLS INDIA LTD.

Havells India Ltd.
Neemrana, Distt. Alwar (Raj)

Date - 20.08.2021

HSD2LS60011
Rev - 01

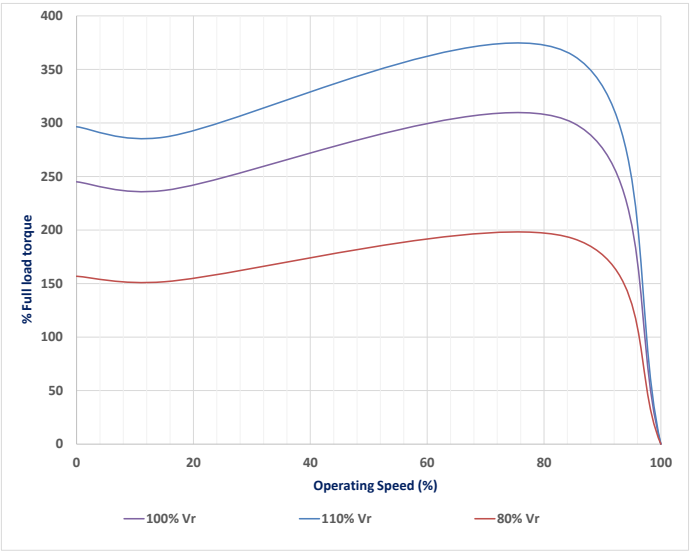
MOTOR DATA SHEET

SR NO.	DESCRIPTION	UNIT	
1	Make		Havells India Ltd.
2	Type of motor		AC 3 PH. Sq. Cage Induction Motor
3	Efficiency Class		IE2
4	Frame size		MHEE160LZA6
5	Ambient	Deg C	50
6	Nominal output	kW/HP	11/15
7	Duty		S1
8	Pole / Rated Speed (RPM)		6/960
9	Insulation Class		F
10	Temperature Rise		Limited to Class B
11	Mounting arrangement		B3
12	T.B. Position (Viewed from DE side)		TOP
13	Voltage	Volts	415± 10%
14	Rated Frequency	Hz	50 ± 5%
15	Allowable combined variation		± 10%
16	Type of connection		Delta(Δ)
17	Full load current	Amps.	22.4
18	Efficiency at rated Voltage at 100% load	%	88.7
19	Efficiency at rated Voltage at 75% load	%	88.7
20	Efficiency at rated Voltage at 50% load	%	87.8
21	Power factor at rated Voltage		0.77
22	Starting torque at rated Voltage	%	245
23	Pull-out torque at rated Voltage	%	300
24	Starting current at rated Voltage	%	650
25	Construction / Method of cooling		TEFC / IC411
26	Degree of protection of enclosure		IP 55
27	Paint Shade		Smoke Grey
28	Type of bearing DE/NDE		6309 2Z/6209 2Z
29	Grease Type		Lithium Base, Grade-3
30	Cable Entry		2xM40x1.5
31	Motor GD²	kgm²	0.45
32	Net weight	kg	133
33	Applicable standard		IS 12615

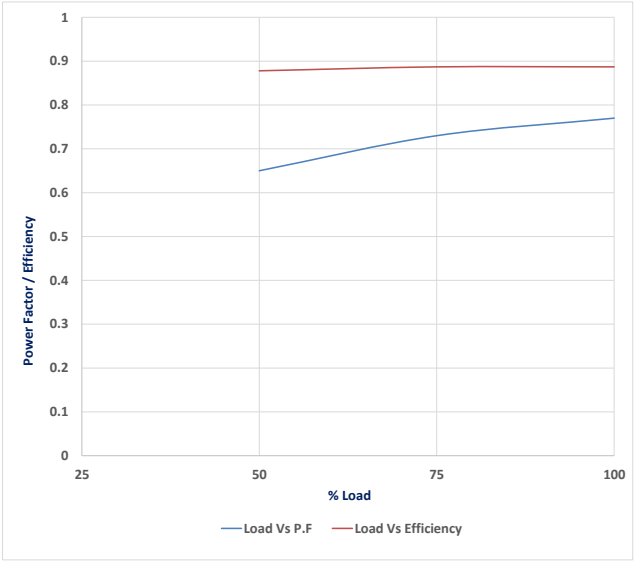
Note:- All Performance figures are subject to tolerance as per IS 12615.

Customer Name	:							
Application	:							
TDS Number	:							
Rating	:	11	kW	**Starting Time without Load/With Load**	:	0.15 | 0.5	sec	
Pole	:	6		**J Motor(Kgm2)**	:	0.45		
Frame Size	:	MHEE160LZA6		**Withstand Time(HOT/COLD)**	:	15 | 26	sec	

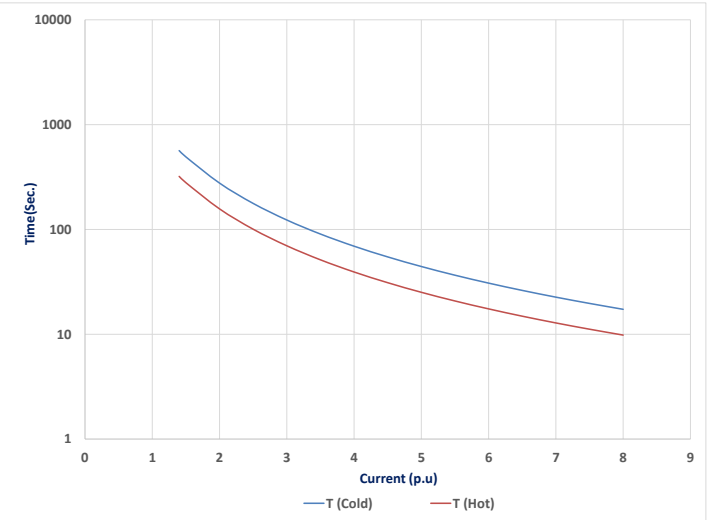
Torque Vs Speed



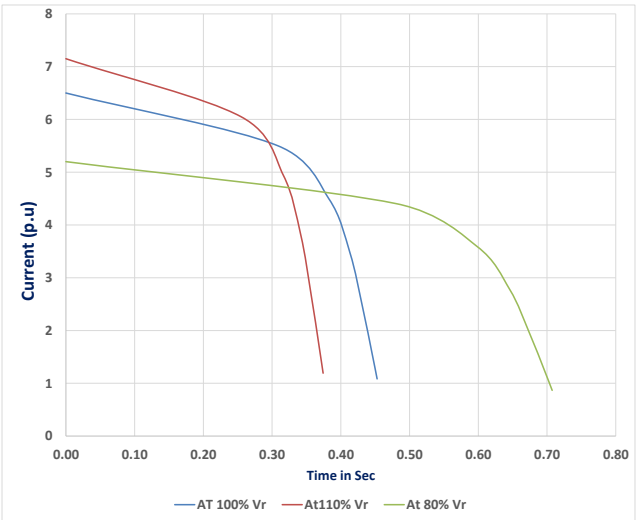
Load Vs Efficiency & Power Factor



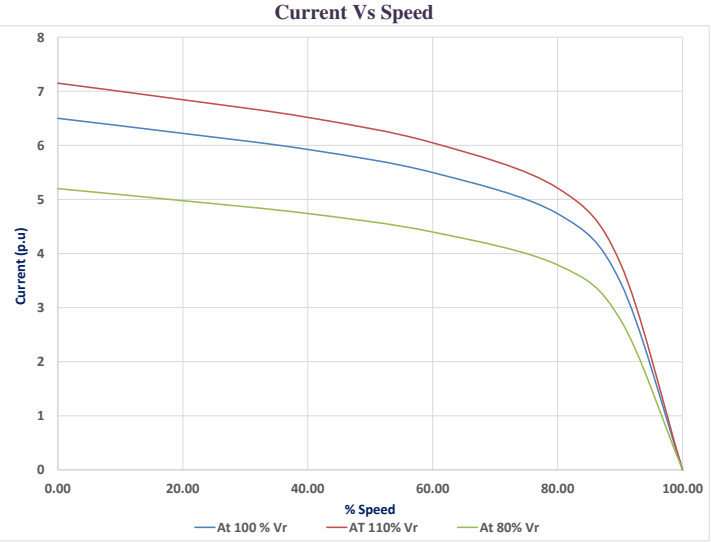
Thermal Withstand Time



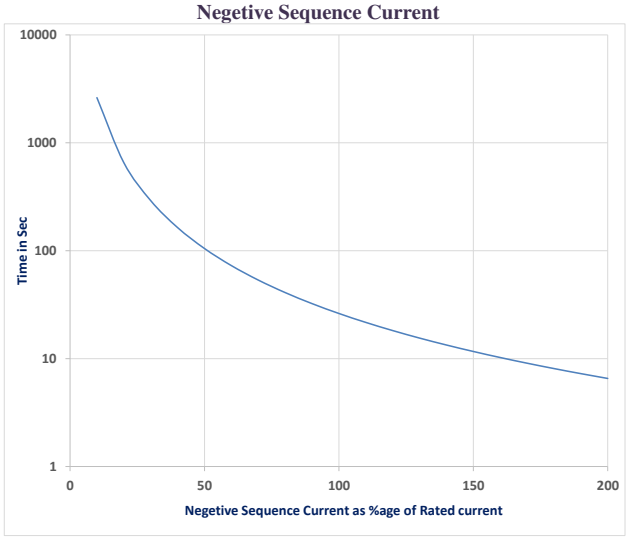
Current Vs Time



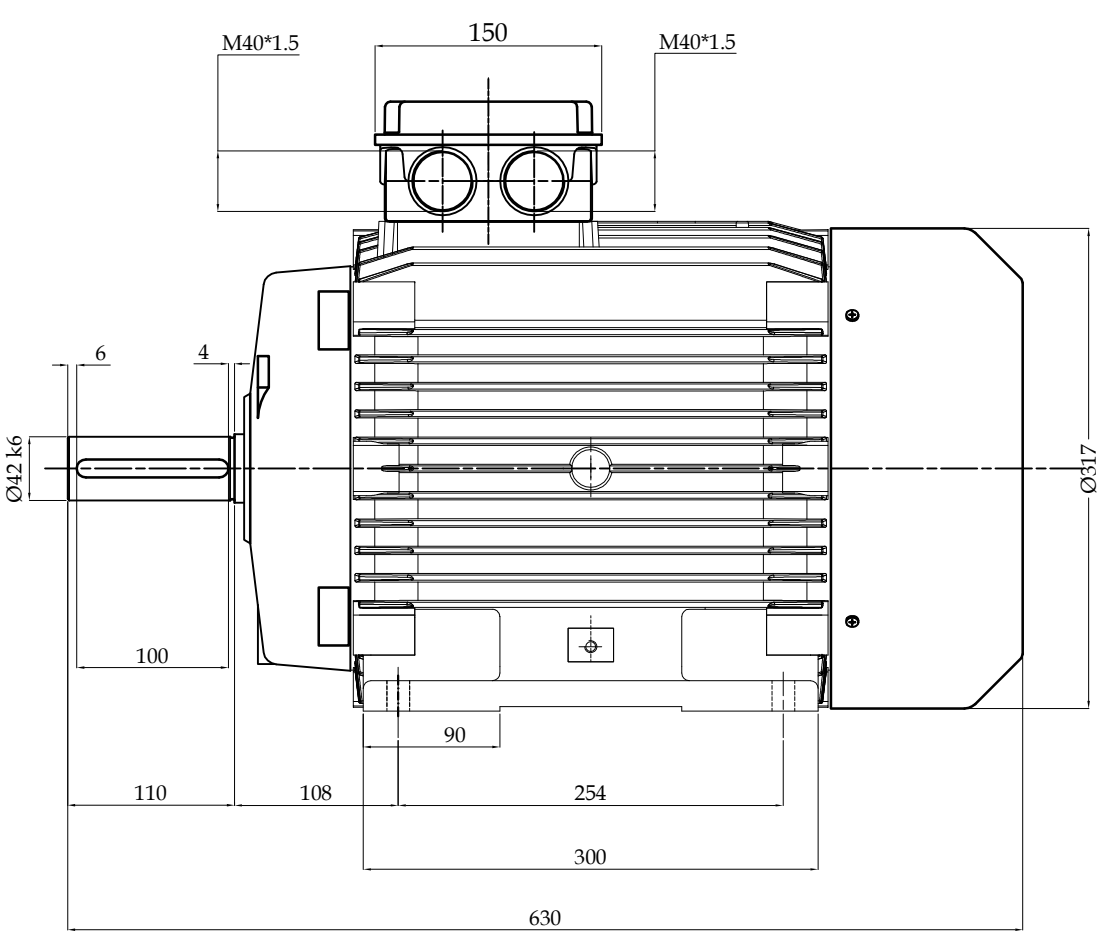
Current Vs Speed

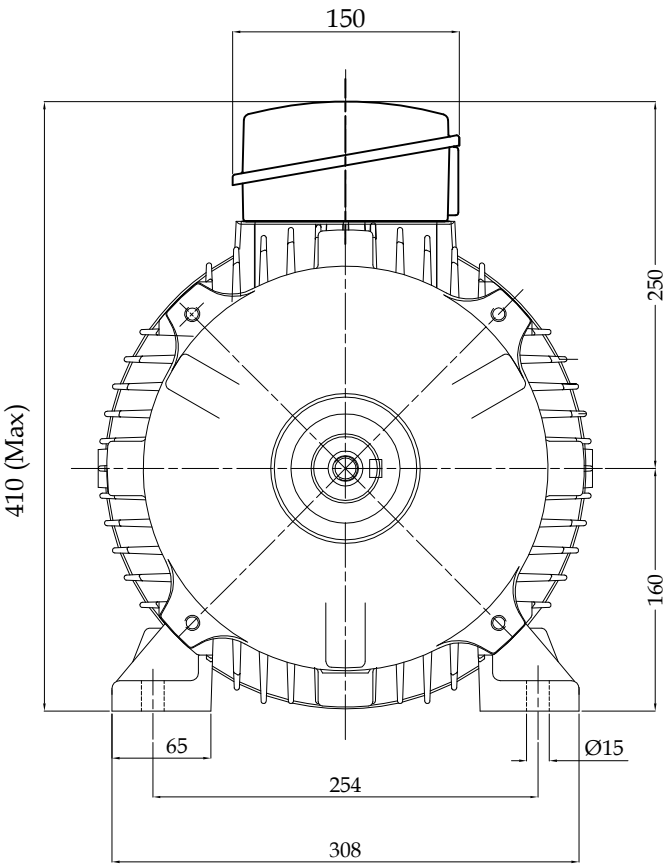


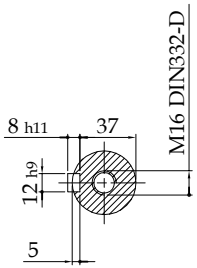
Negetive Sequence Current



HM_TEMP_2068

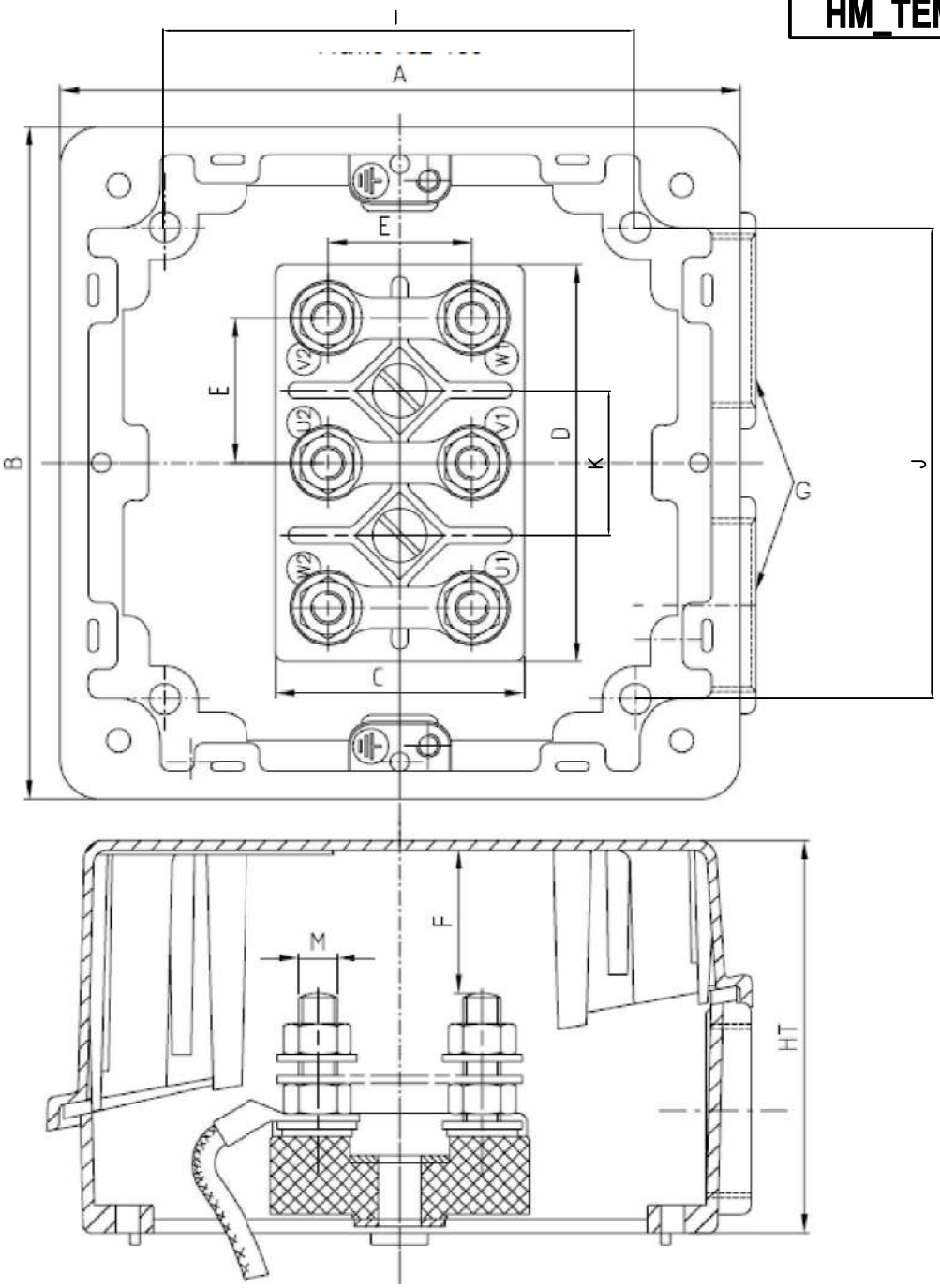






CAD DRAWING NO MANUAL ALTERATION				
Roughness Ra in accordance to UNI 3963	STD G.A. Dwg. 160L FRAME B3 TEFC DESCRIPTION		CAST IRON BODY MOTOR MATERIAL	WEIGHT
Unspecified Radii assumed as 0.5mm Unspecified Drafts, Angles assumed as 1° All Dimensions are in mm	REF.	FRAME 160L FRAME	DRAWING No. HM_TEMP_2068	
General Tolerances according to ISO2768-mK / EN 22768-1/2	CODE	CLIENT –	DRAWN PIYUSH	REVISION 00
HAVELLS INDIA LTD.		SCALE 1:5 / FORMAT A3	CHECKED PIYUSH APPROVED --	DATE 05/12/2019

HM_TEMP_2065



R1

FRAME	DIMENSIONS IN MM											
	A	B	C	D	E	F	I	J	K	G	HT	M
132	133	133	40	64	23	30	87	87	25	2-M32X1.5	66	M5
160	150	150	52	82	30	40	116	75	30	2-M40X1.5	79	M6

CAD DRAWING
NO MANUAL ALTERATION

Nr.	Data	Revisione	Nome
R1	18/07/2020	DIMENSIONS ADDED AS PER CUSTOMER REQUIREMENT	PIYUSH
	--	REVISION MARKED R1	

Roughness Ra in accordance to UNI 3963 (12.5 / 3.2 / 0.8)
Unspecified Radii assumed as 0.5mm
Unspecified Drafts, Angles assumed as 1°
All Dimensions are in mm
General Tolerances according to ISO2768-mK / EN 22768-1/2

TERMINAL BOX ASSEMBLY — DESCRIPTION
ALUMINIUM — MATERIAL
– — WEIGHT

REF.
FRAME: 132 & 160
DRAWING No.: HM_TEMP_2065
CODE: –
CLIENT: ---
DRAWN: PIYUSH
REVISION: R1
SCALE: 1:1
FORMAT: –
CHECKED: PIYUSH
APPROVED: --
DATE: 05/12/2019

HAVELLS INDIA LTD.

Havells India Ltd.
Neemrana, Distt. Alwar (Raj)

HAVELLS

HS25D2LS60011

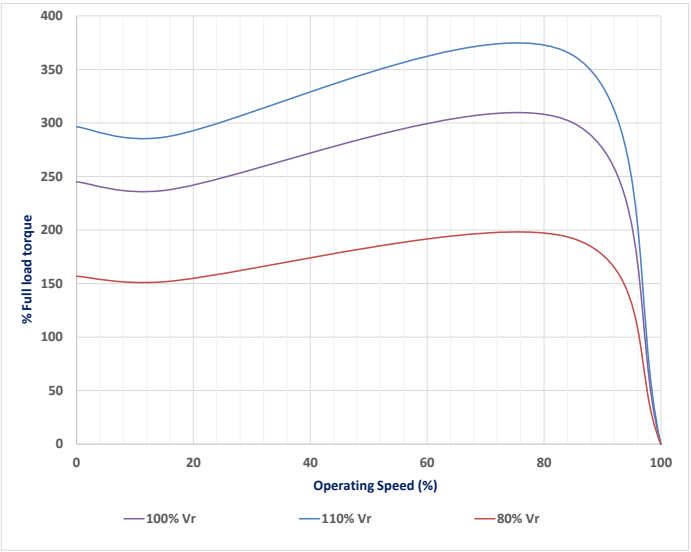
MOTOR DATA SHEET

SR NO.	DESCRIPTION	UNIT	
1	Make		Havells India Ltd.
2	Type of motor		AC 3 PH. Sq. Cage Induction Motor
3	Efficiency Class		IE2
4	Frame size		MHEE160LZA6
5	Ambient	Deg C	50-250 ºC / 2 HRS
6	Nominal output	kW/HP	11/15
7	Duty		S1-S2
8	Pole / Rated Speed (RPM)		6/960
9	Insulation Class		H(Smoke)
10	Temperature Rise		Limited to Class B
11	Mounting arrangement		B3
12	T.B. Position (Viewed from DE side)		TOP
13	Cable Gland Material		Metallic
14	Fly Lead Length / Material		1 meter / Fire Retarded
15	Voltage	Volts	415± 10%
16	Rated Frequency	Hz	50 ± 5%
17	Allowable combined variation		± 10%
18	Type of connection		Delta(Δ)
19	Full load current	Amps.	22.4
20	Efficiency at rated Voltage at 100% load	%	88.7
21	Efficiency at rated Voltage at 75% load	%	88.7
22	Efficiency at rated Voltage at 50% load	%	87.8
23	Power factor at rated Voltage		0.77
24	Starting torque at rated Voltage	%	245
25	Pull-out torque at rated Voltage	%	300
26	Starting current at rated Voltage	%	650
27	Construction / Method of cooling		TEAO / IC418
28	Degree of protection of enclosure		IP 55
29	Paint Shade		Smoke Grey
30	Type of bearing DE/NDE		6309 Z/6209 Z
31	Grease Type		High Temperature Grease
32	Cable Entry		2xM40x1.5
33	Motor GD²	kgm²	0.45
34	Approx Net weight	kg	133
35	Applicable standard		IS/IEC 60034-1 & EN 12101-3

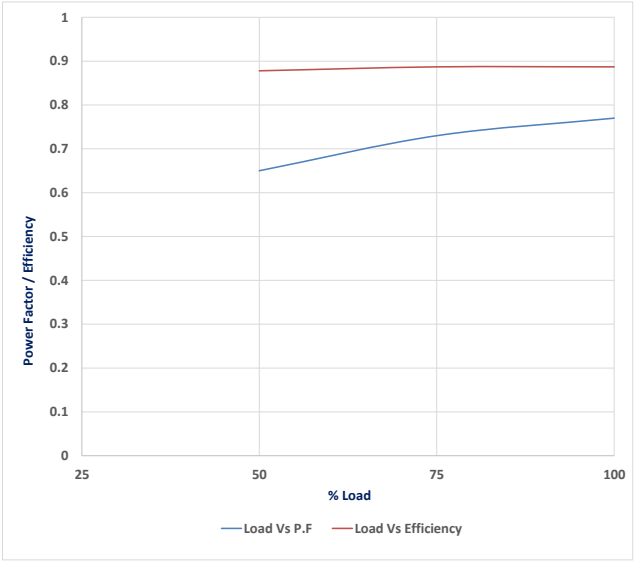
Note:- All Performance figures are subject to tolerance as per IS/IEC.

Customer Name	:							
Application	:							
TDS Number	:							
Rating	:	11	kW	**Starting Time without Load/With Load**	:	0.15 | 0.5	sec	
Pole	:	6		**J Motor(Kgm2)**	:	0.45		
Frame Size	:	MHEE160LZA6		**Withstand Time(HOT/COLD)**	:	15 | 26	sec	

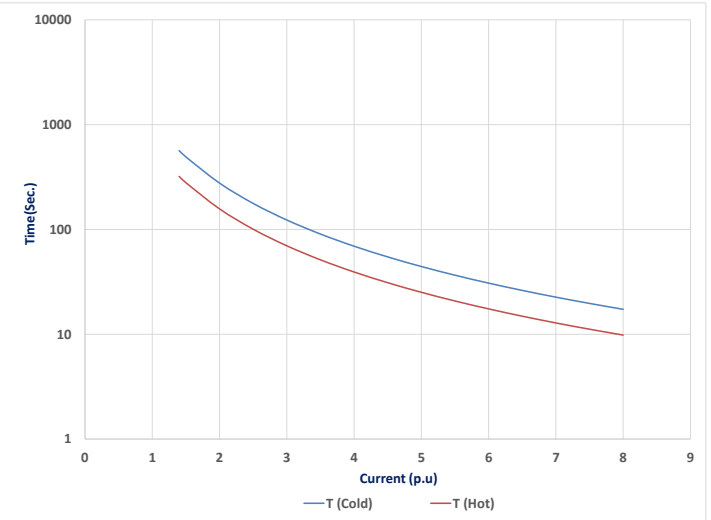
Torque Vs Speed



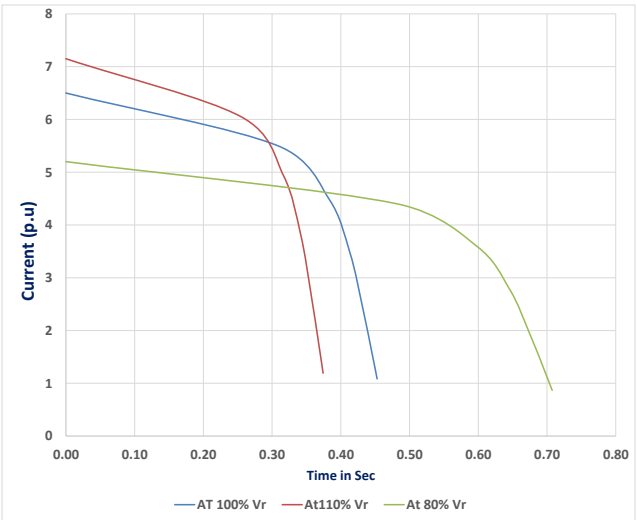
Load Vs Efficiency & Power Factor



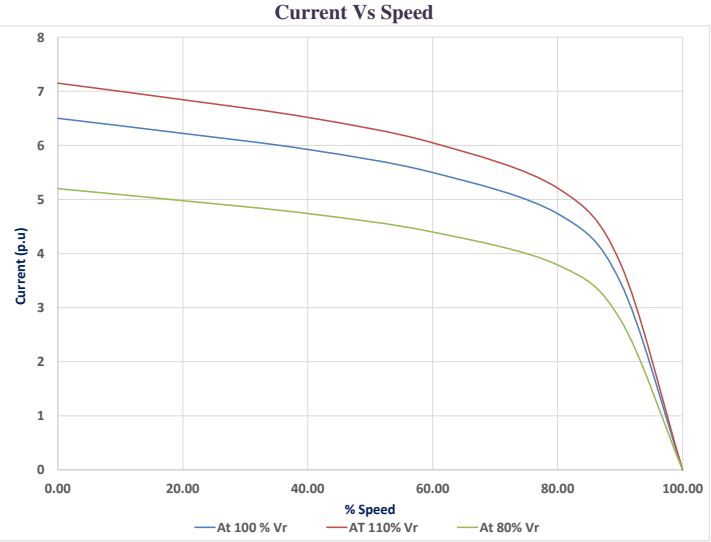
Thermal Withstand Time



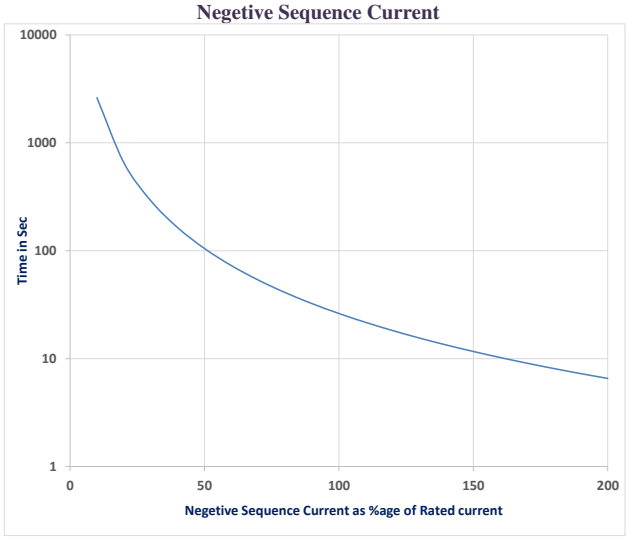
Current Vs Time



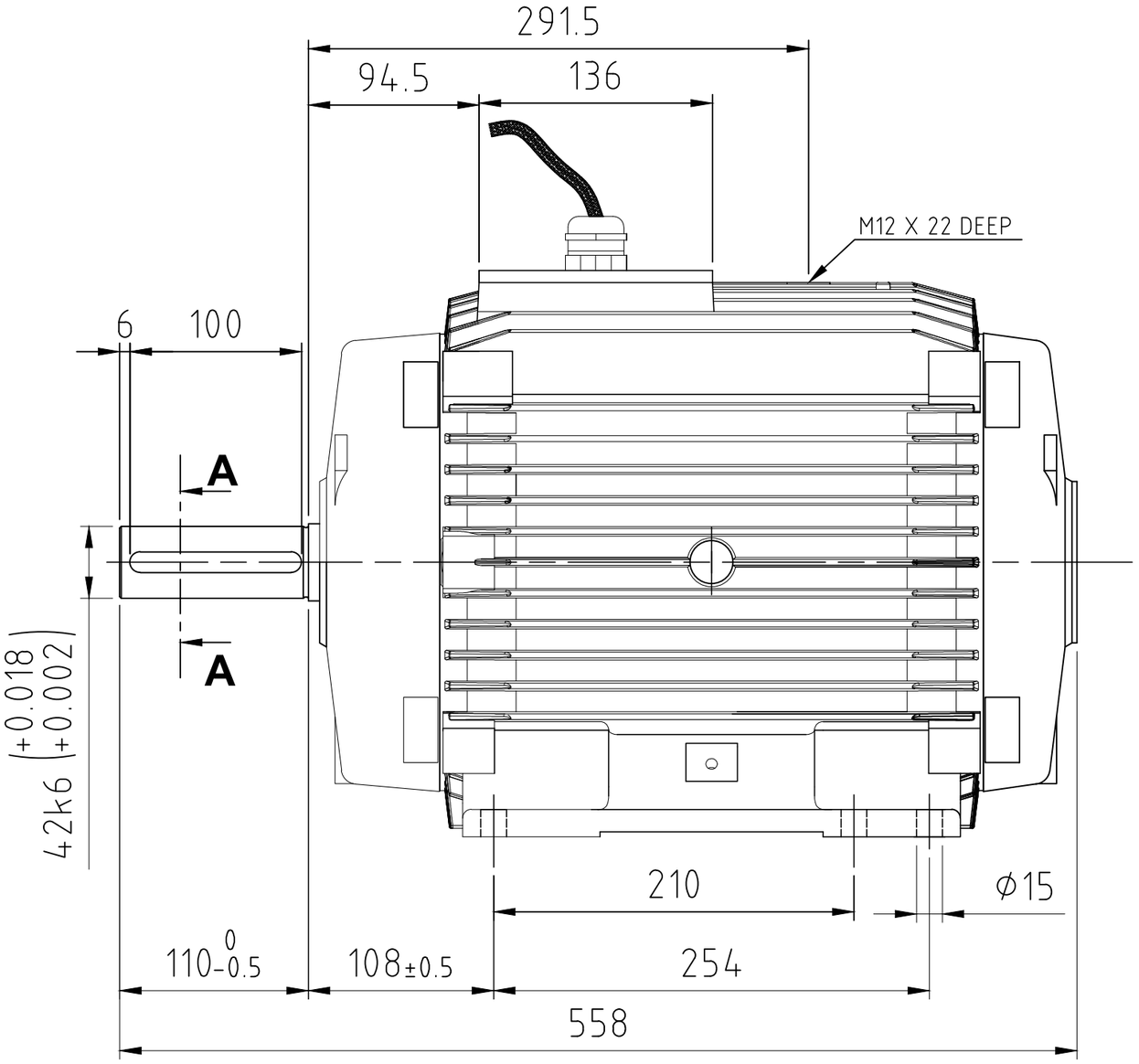
Current Vs Speed

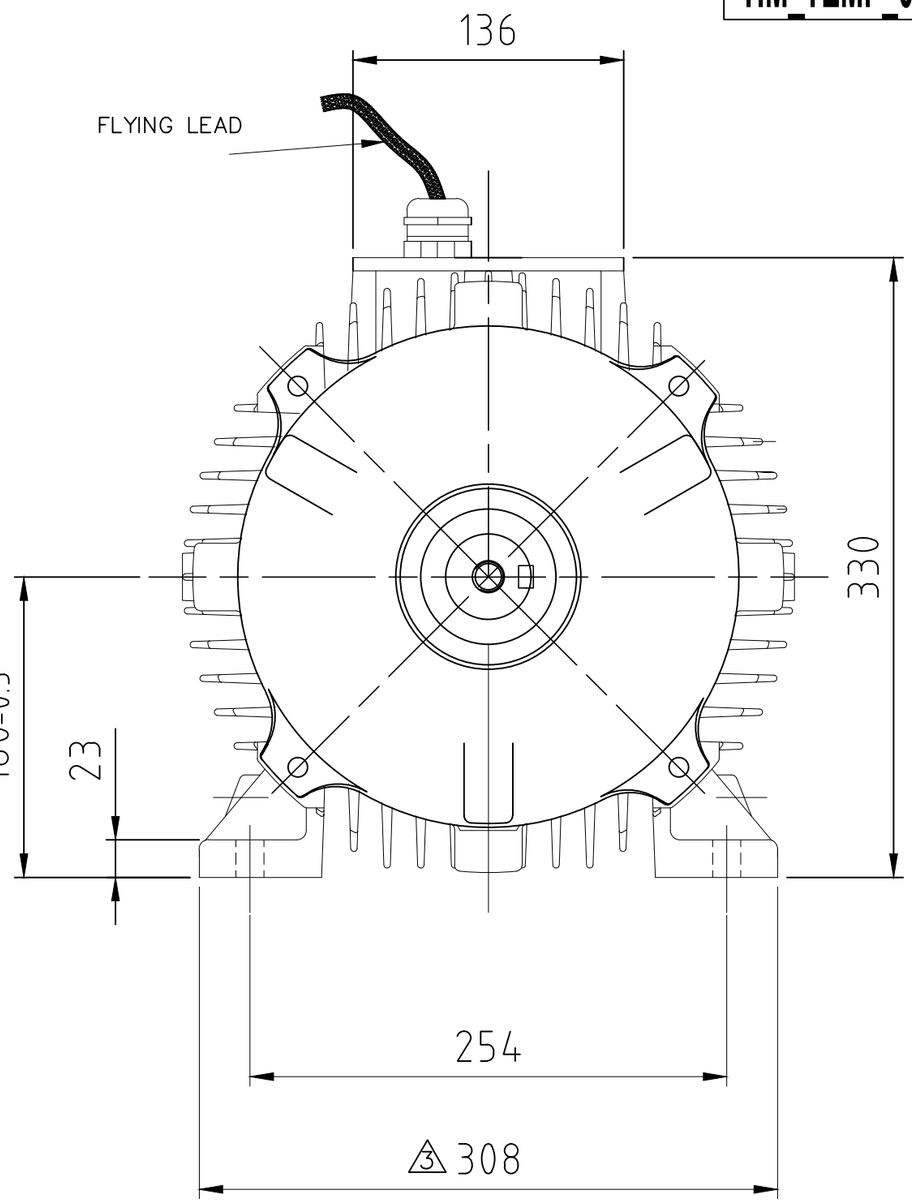


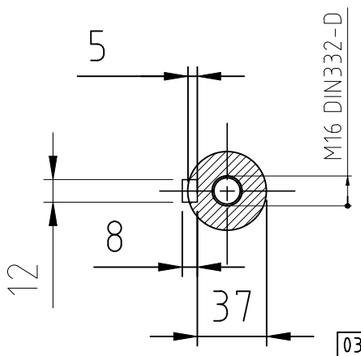
Negetive Sequence Current



HM_TEMP_0617







SECTION A-A

Nr.	Data	Revisione	Nome
03	31/08/2021	PAD TO PAD LENGTH REVISED. -	SAHIL
02	20/08/2020	EYE BOLT SIZE & POSITION SHOWN AS PER CUSTOMER REQUIREMENT. -	PIYUSH
01	22/06/18 -	CABLE GLAND POSITION REVISED -	VIKAS

CAD DRAWING
NO MANUAL ALTERATION

Roughness Ra in accordance to UNI 3963 (12.5 / 3.2 / 0.8)

Unspecified Radii assumed as 0.5mm
Unspecified Drafts, Angles assumed as 1°
All Dimensions are in mm

General Tolerances according to ISO2768-mK / EN 22768-1/2

GA–DRG. 160ML B3 TE MOTOR WITH FLR

DESCRIPTION		MATERIAL	WEIGHT
REF. –	FRAME 160ML	DRAWING No. HM_TEMP_0617	
CODE –	CLIENT	DRAWN VIKAS	REVISION R3
	SCALE 1:5 – / FORMAT A3	CHECKED KKG / APPROVED KKG	DATE 19/09/2014

HAVELLS INDIA LTD.

KRUGER

CCE Series

IN-LINE FAN - DIRECT DRIVEN

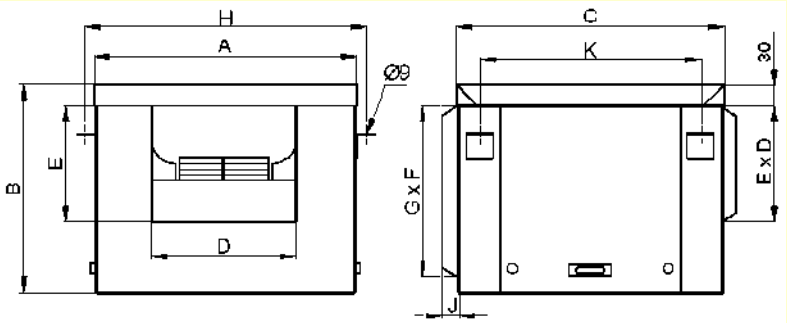
In-Line Direct Driven Fan – **CCE Series**

- *Cabinet is manufactured in galvanized sheet steel.*
- *Incorporates a direct driven, DIDW forward curved centrifugal fan.*
- *Removable access panel on both sides for easy access to fan and motor.*
- *Flanged inlet and outlet for easy ductwork connection.*
- *Operating temperature -40°C to +40°C*

Optional Features:

- *Internal Insulation.*
- *Filter with throwaway media.*
- *Different discharge orientation.*

Dimension



Model	A	B	C	D	E	F	G	H	J	K	Weight (kg)
CCE 140	403	316	268	198	111	210	160	441	25	233	11
CCE 160	453	356	308	204	204	230	270	490	25	265	16
CCE 7-7	442	401	392	263	232	240	344	491	25	340	18
CCE 8-8	502	451	442	291	260	291	384	549	25	379	21
CCE 9-7T	572	401	393	236	266	348	322	621	25	340	24
CCE 9-7	573	451	442	236	266	348	382	619	25	378	27
CCE 9-9T	572	401	393	302	266	348	322	621	25	340	25
CCE 9-9	573	451	442	302	266	348	382	619	25	378	27
CCE 10-8	652	561	502	269	293	410	462	699	25	431	33
CCE 10-10	652	561	502	335	293	410	462	699	25	431	35
CCE 12-9	743	631	573	313	345	510	547	790	25	526	42
CCE 12-12	743	631	573	399	345	510	547	790	25	526	44

All dimension in mm.

Sr no 30

Sr no 34

Sr no 35

Kruger Ventilation Industries (India) Pvt Ltd certifies that the **CCE series** shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

Sr. No 11,12,14,15,19, 20,23,24,27,28

Technical data

Model	Max Q (m^3/h)	Motor Installed Power (W)	Maximum Motor Input Power (W)	Motor Protection	Phase	Hz	Maximum Current (A)	Voltage (V)	Capacitor (µF/V)	Insulation Class	Lp (A) at 3m free discharge (dB (A))*	Speed (RPM)
CCE 140 4P-1 1SY	641	70	112	IP20	1	50	1	220	4.0/450	F	61	1450
CCE 160 4P-1 1SY	914	70	148	IP20	1	50	1	220	4.0/450	F	52	1400
CCE 7-7 4P-1 1SY	1577	165	255	IP20	1	50	1	220	7.5/450	F	52	1300
CCE 8-8 4P-1 1SY	1613	165	328	IP20	1	50	1	220	7.5/450	F	50	1300
CCE 9-7T 4P-1 3SY	1879	245	560/500/430	IP20	1	50	2.6/2.3/2.1	220	7.5/400	F	51	1200/1150/1100
CCE 9-7 4P-1 3SY	2084	245	590/500/430	IP20	1	50	2.7/2.5/2.0	220	7.5/400	F	47	1200/1150/1100
CCE 9-9T 4P-1 3SY	2426	350	780/520/360	IP20	1	50	3.5/2.5/1.8	220	12.5/450	F	56	1300/1100/800
CCE 9-9 4P-1 3SY	2574	350	800/520/360	IP20	1	50	3.6/2.4/1.7	220	12.5/450	F	51	1300/1100/800
CCE 10-8 4P-1 3SY	3639	550	1370/1120/940	IP20	1	50	6.3/5.2/4.5	220	16.0/450	F	59	1300/1250/1150
CCE 10-10 4P-1 3SY	3857	550	1420/1100/950	IP20	1	50	6.6/5.2/4.6	220	16.0/450	F	59	1300/1250/1150
CCE 12-9 6P-1 3SY	4547	709	1150/700/450	IP20	1	50	5.8/3.6/2.5	220	12.5/450	F	59	940/820/620
CCE 12-12 6P-1 3SY	5200	709	1220/700/450	IP20	1	50	6.2/3.7/2.5	220	12.5/450	F	62	940/820/620

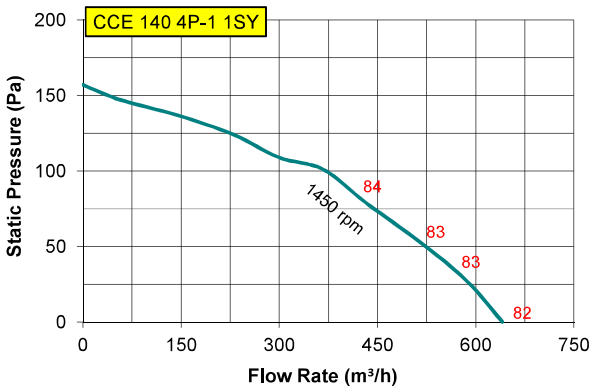
Sr no 30

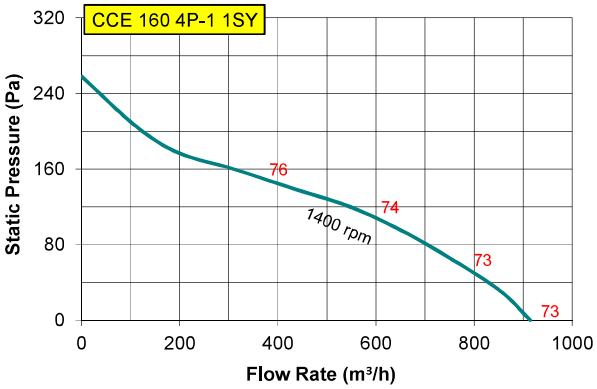
Sr no 34

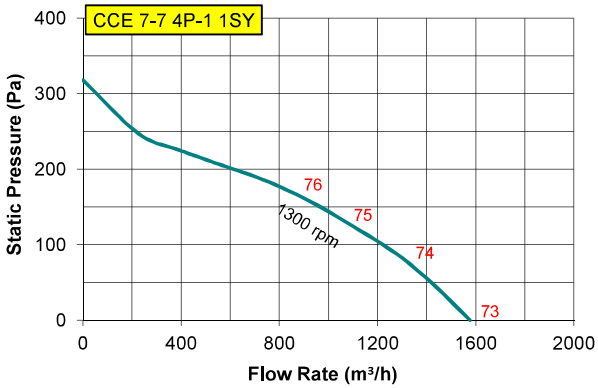
Sr. No 11,12,14,15,19, 20,23,24,27,28

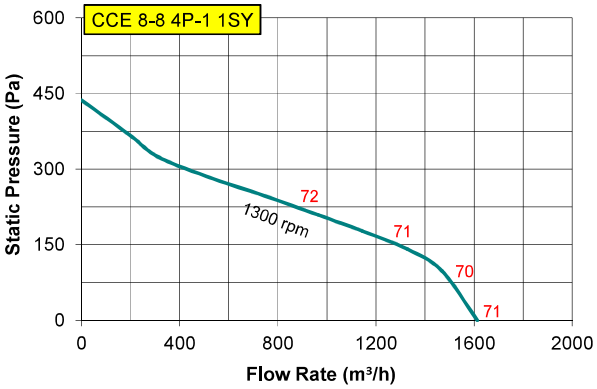
Sr no 35

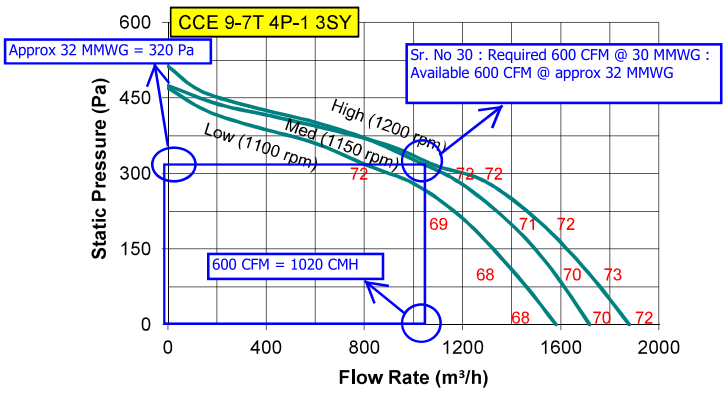
- Values shown are for inlet Lwi(A) sound power levels for installation type D – Ducted inlet, Ducted outlet. The A-weighted sound ratings shown have been calculated per AMCA International Standard 301. Ratings include the effects of duct end correction.
- Performance certified is for installation type D – Ducted inlet, Ducted outlet.
- Performance ratings do not include the effects of appurtenances (accessories).
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.
- Lp(A) at 3m free discharge dB(A) levels are not licensed by AMCA International.

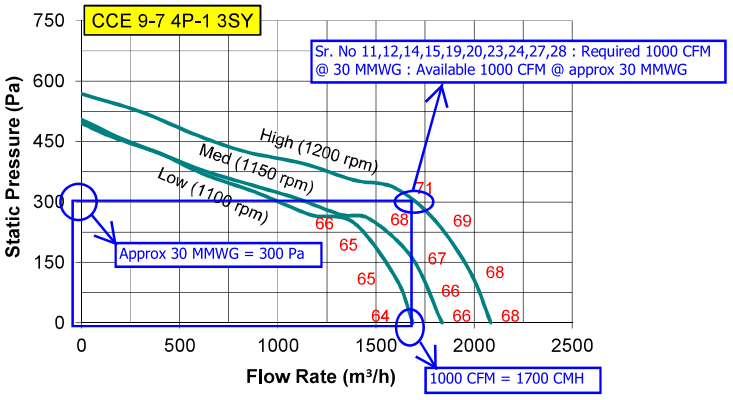












- Values shown are for inlet Lwi(A) sound power levels for installation type D – Ducted inlet, Ducted outlet. The A-weighted sound ratings shown have been calculated per AMCA International Standard 301. Ratings include the effects of duct end correction.
- Performance certified is for installation type D – Ducted inlet, Ducted outlet.
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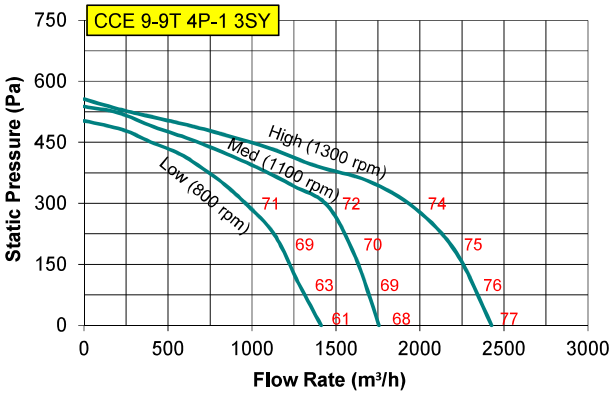
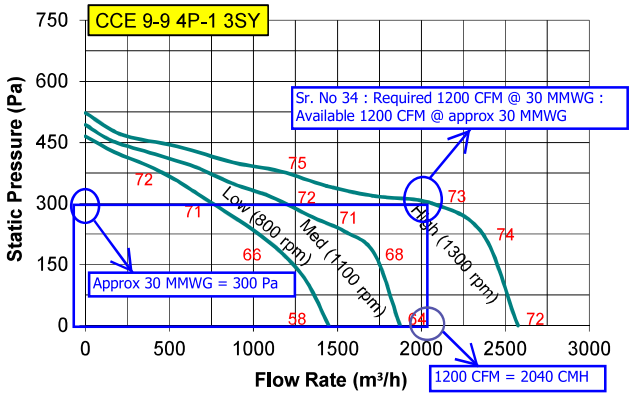
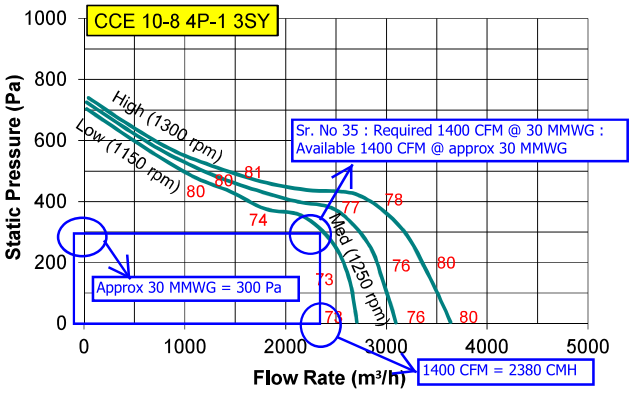
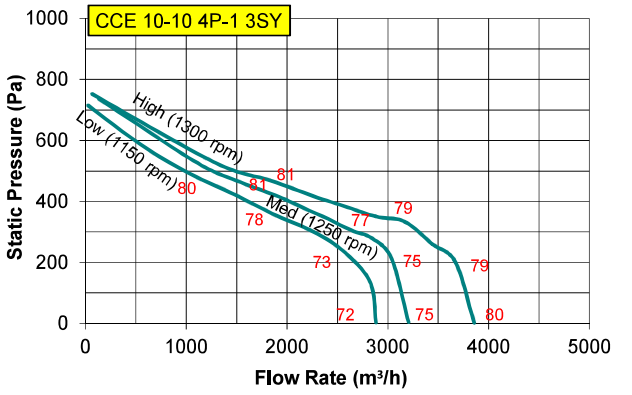
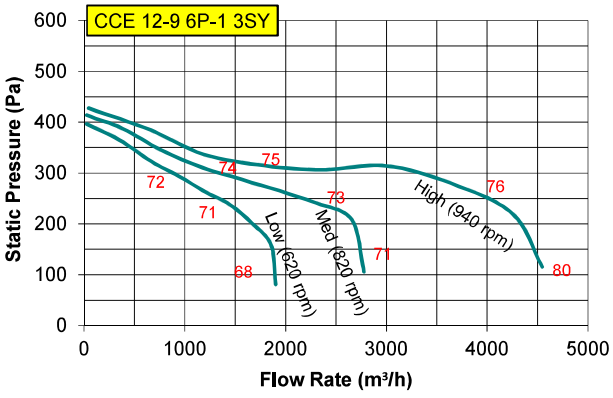
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.

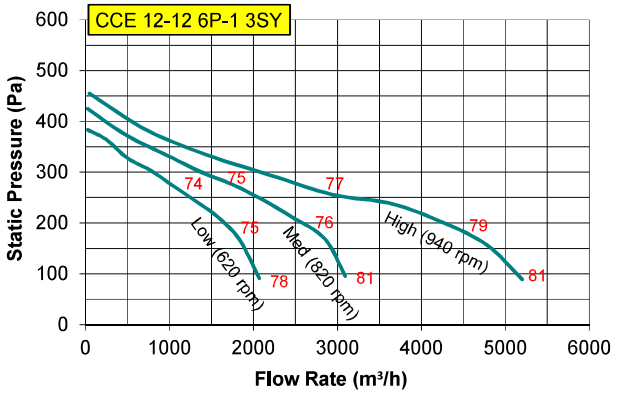












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- Speed (RPM) shown is nominal. Performance is based on actual speed of test.

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The company is always improving and developing its products, therefore the company reserves the right of making changes to the illustrated products. Certified dimension can be provided upon request.

LEA138.E0.KAG August 2021
Edition 3
Printed in August 2021

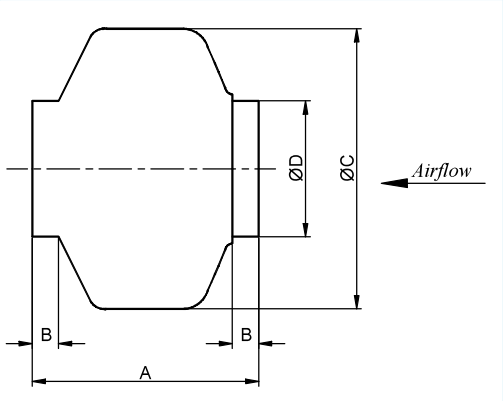
TSK II Series

IN-LINE CENTRIFUGAL DUCT FAN

In-Line Centrifugal Duct Fan – TSK II Series

- *TSK II series are designed for direct in-line connection with industrial circular ducting of standard diameter.*
- *Suitable for applications in residential, commercial and industrial exhaust and supply ventilation such as bathrooms, kitchens, offices, factories, shops, bars, gymnasiums, restaurants etc.*
- *Complete range of inlet and outlet diameters to allow installations in most standard sizes of commercial ducts.*
- *The motor and impeller assembly are suitable for operation at any angle and deliver exceptional airflow performances against the high static pressures typically found in ducted ventilation systems.*
- *All TSK II series fan casing are manufactured from corrosion resistant pressed galvanised sheet steel.*
- *Non-stalling backward curved impeller which is factory matched to the corresponding external rotor motor and dynamically balanced to ISO 1940 standards for vibration free operation.*
- *All models are supplied as standard with a remotely mounted wiring junction box to provide the installer with a completely flexible choice for positioning and installation.*
- *Motors of this TSK II series are fully speed controllable using electronic or auto-transformer voltage control regulators.*
- *Enclosed, single phase, 230V, 50/60 Hz external rotor type, motors included sealed for life ball bearing assemblies and Class B, IP44 protection with an internal automatic reset safety thermal overload protection device as standard.*
- *Operating temperature - 40℃ to +40℃*

Dimensions



Model	A	B	ØC	ØD	Wt (kg)
TSK II 100L	194	23	243	98	3
TSK II 125L	195	27	243	123	3
TSK II 160L	222	28	333	157	5
TSK II 200L	223	25	333	198	5
TSK II 250L	206	27	333	248	6
TSK II 315L	230	25	401	312	8

Serial number 10

Kruger Ventilation Industries Pte Ltd certifies that the **TSK II series** shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA publication 211 and AMCA publication 311 and comply with the requirements of the AMCA Certified Ratings Program.

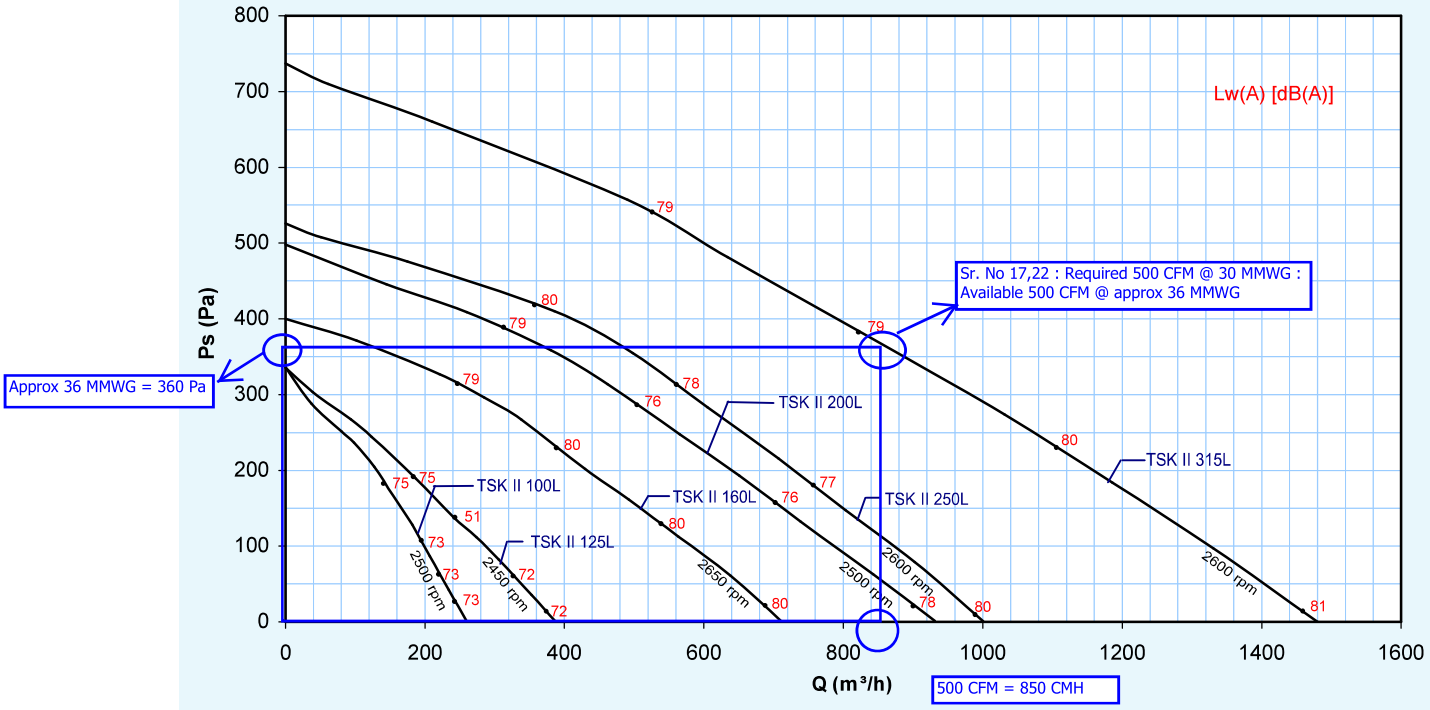
Technical Data

Model	Max Q m3/h	Max Input Power W	Motor Protection	Phase	N° Pole	Hz	Max Amp	Insulation Class	dB (A) at 3m	RPM
TSK II 100L	265/267	73/91	IP44	1	2	50/60	0.33/0.35	B	52/53	2500/2650
TSK II 125L	395/400	75/95	IP44	1	2	50/60	0.35/0.38	B	51/51	2450/2550
TSK II 160L	726/780	121/178	IP44	1	2	50/60	0.55/0.60	B	59/60	2650/2750
TSK II 200L	950/1045	141/201	IP44	1	2	50/60	0.72/0.80	B	57/58	2500/2700
TSK II 250L	1020/1125	140/212	IP44	1	2	50/60	0.80/0.82	B	59/61	2600/2800
TSK II 315L	1509/1688	240/352	IP44	1	2	50/60	1.45/1.50	B	60/63	2600/2750

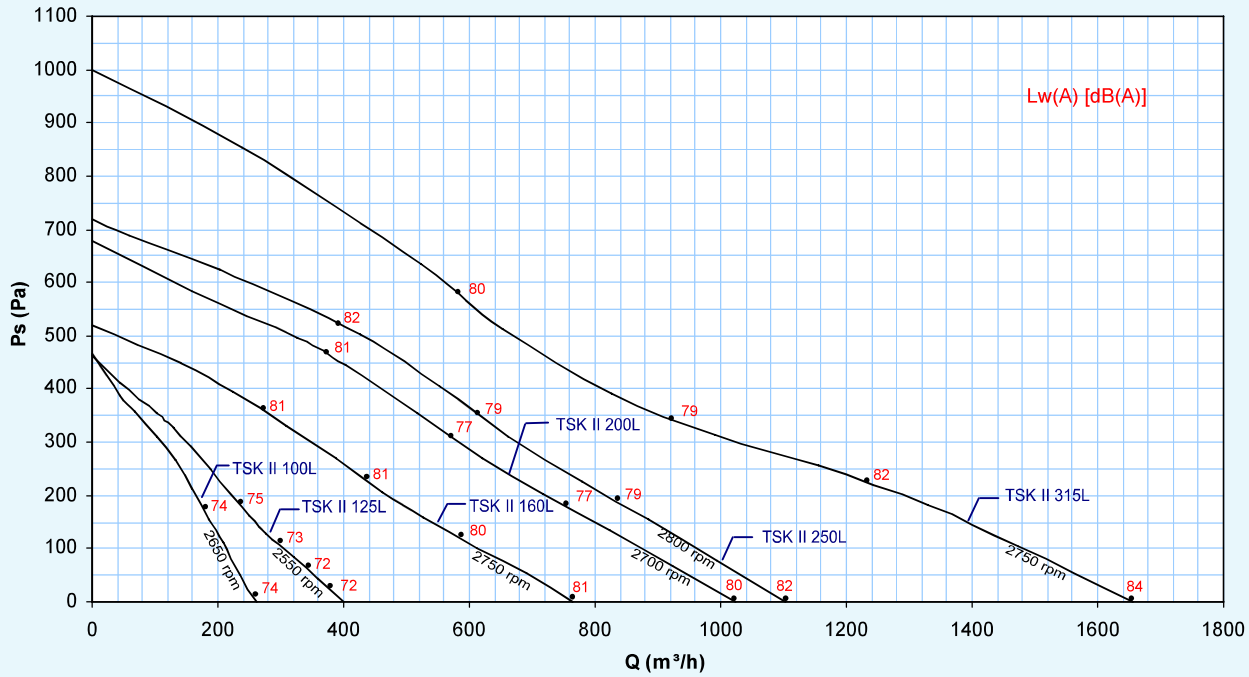
- *Speed (RPM) shown is nominal. Performance is based on actual speed of test.*
- *Performance ratings do not include the effects of appurtenances (accessories).*
- *dB(A) at 3m with ducted inlet and outlet at free field conditions.*

Serial number 17,22

Performance Data - 50Hz



Performance Data - 60Hz



- *Speed (RPM) shown is nominal. Performance is based on actual speed of test.*
- *Performance ratings do not include the effects of appurtenances (accessories).*
- *The A-weighted sound ratings shown have been calculated per AMCA standard 301. Values shown are for inlet Lw(A) sound power levels for installation type D: ducted inlet, ducted outlet. Ratings include the effect of duct end correction.*

KRUGER

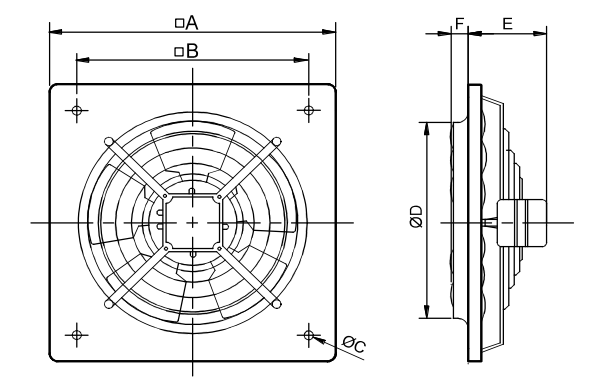
APM Series

COMPACT AXIAL FANS

Plate Mounted Axial Flow Fans – **APM Series**

- *APM Series is designed for direct wall-mounting or panel-mounting.*
- *Suitable for ventilation application where the extraction of small volume of air at low pressure is required, eg. cafes, bars, small restaurants, commercial premises and small workshops.*
- *Complete with one piece bell mouth inlet and mounting plate manufactured from pressed galvanised steel with polyester painting finish.*
- *Fitted with steel finger-proof guard as standard mounted at the inlet side of fan.*
- *5-bladed impeller manufactured from aluminium finished with epoxy-polyester painting.*
- *Incorporates single phase shaded pole asynchronous induction motor and an auto reset thermal overload protection device.*
- *Supplied with a cable for connection to electrical supply.*
- *Max. operating temperature: APM 200-355: +40 ℃*

Dimension



Model	□A	□B	ØC	ØD	E	F	Wt (kg)
APM 200	266	222	9	205	88	19	1.8
APM 250	333	275.5	9	255	99	31	2.2
APM 315	400	336.5	10.5	305	99	35.5	3.2
APM 355	465	390	10.5	361	106	34.5	4.3

All Dimensions in mm

Sr. No 18,26,31,33

Technical Data

Sr. No 18,26,31,33 : Required 150 & 200 CFM : Available 295 CFM at Free Flow.

Model	Max Q m³/h	Power W	Motor Protection	Motor	N° Pole	Hz	Max Amp	Volt	Insulation Class	dB (A) at 3m	RPM
APM 200	500	18	IP44	1 Phase	4	50	0.08	230	B	36	1300
APM 250	900	22	IP44	1 Phase	4	50	0.10	230	B	42	1300
APM 315	1400	30	IP44	1 Phase	4	50	0.15	230	B	48	1300
APM 355	1800	40	IP44	1 Phase	4	50	0.17	230	B	53	1300

** dB(A) at 3m measured at free discharge.*

KRUGER

APL Series

PROPELLER FANS

Propeller Fans – APL Series

- Propeller fan for wall or panel mounting suitable for supply or exhaust use.
- Sickle Blade impellers, installed with the external rotor motors.
- Wall plate is made of high grade steel sheet with painted finish, galvanized steel sheet wall plate can be supplied upon request.
- Fan impellers are statically and dynamically balanced to ISO 1940 standard.
- Low noise level with high efficiency.
- Accessories such as speed controller and mounting accessories can be supplied upon request.
- Model APL 710-1000 are not licensed by AMCA International.

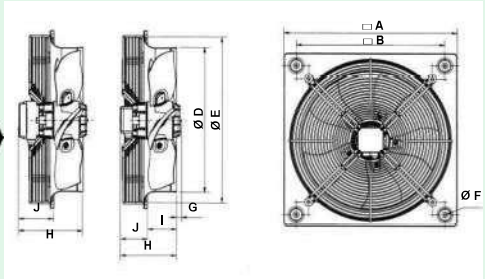
Kruger Ventilation Industries Asia Co., Ltd certifies that the model APL 315-630 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 311 and comply with the requirements of the AMCA Certified Ratings Program. Model APL 710-1000 are not licensed by AMCA International.

Dimension

315 - 710

Sr. No 16,21,25,29,32

1 PHASE 3 PHASE



Model	□A	□B	ØD	ØE	ØF	G	H	I	J	Wt (kg)
APL 315 4P-1 1S	400	330	315	329	10	-	149	68	82	7.0
APL 355 4P-1 1S	450	380	355	371	10	-	156	75	82	7.5
APL 400 4P-1 1S	500	420	400	422	10	12	200	78	122	9.0
APL 450 4P-1 1S	560	480	450	476	10	-	204	91	114	11.5
APL 500 4P-1 1S	630	560	500	536	10	13	201	97	104	16.0
APL 500 6P-1 1S	630	560	500	536	10	-	201	97	104	16.0
APL 560 4P-1 1S	710	630	560	596	10	20	213	99	114	21.5
APL 560 6P-1 1S	710	630	560	596	10	2	213	99	114	21.5
APL 560 6P-3 1S	710	630	560	596	10	-	188	99	89	21.5
APL 630 4P-3 1S	800	710	630	674	12	25	182	103	79	24.0
APL 630 6P-3 1S	800	710	630	674	12	7	182	103	79	24.0
APL 710 6P-3 1S	900	800	710	733	12	11	206	92	115	27.0

Sr. No 13

Technical Data - 50Hz

Sr. No 16,21,25,29,32 : Required 1000 CFM : Available 1100 CFM at Free Flow

Sr. No 13 : Required 2000 CFM : Available 2820 CFM at Free Flow

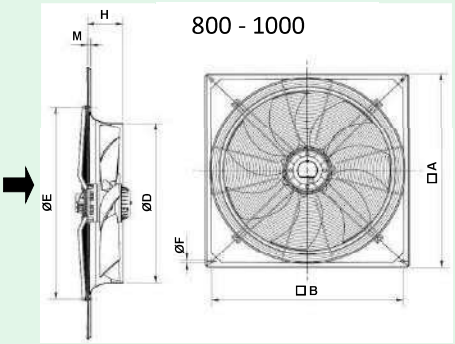
Model	Max Q (m³/h)	Maximum Motor Input Power (W)	Motor Protection	Motor	N° Pole	Hz	Maximum Current (A)		Insulation Class	Lp (A)at 3m free discharge (dB (A))*	Speed (RPM)
							220V	400V			
APL 315 4P-1 1S	1886	112	IP54	Single Phase	4	50	0.60	-	F	46	1420
APL 355 4P-1 1S	2632	145	IP54	Single Phase	4	50	0.70	-	F	48	1345
APL 400 4P-1 1S	4792	268	IP54	Single Phase	4	50	1.20	-	F	52	1355
APL 450 4P-1 1S	6574	457	IP54	Single Phase	4	50	2.00	-	F	55	1325
APL 500 4P-1 1S	8183	867	IP54	Single Phase	4	50	3.60	-	F	56	1390
APL 500 6P-1 1S	5335	228	IP54	Single Phase	6	50	1.10	-	F	44	875
APL 560 4P-1 1S	10577	1084	IP54	Single Phase	4	50	4.60	-	F	57	1370
APL 560 6P-1 1S	6959	371	IP54	Single Phase	6	50	1.71	-	F	48	910
APL 560 6P-3 1S	7718	405	IP54	Three Phase	6	50	-	0.90	F	50	940
APL 630 4P-3 1S	12640	1066	IP54	Three Phase	4	50	-	2.20	F	61	1380
APL 630 6P-3 1S	10317	607	IP54	Three Phase	6	50	-	1.10	F	54	900
APL 710 6P-3 1S	15055	1019	IP54	Three Phase	6	50	-	2.20	F	57	910

* Inlet Lp(A) sound pressure levels at 3m are measured at free discharge in spherical free field condition, inlet Lp(A) (dB(A)) levels are not licensed by AMCA International.

- Performance ratings do not include the effects of appurtenances (accessories).
- Performance certified is for installation type A - Free inlet, Free outlet.
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.
- Model APL 710 is not licensed by AMCA International.

Propeller Fans – APL Series

Dimension



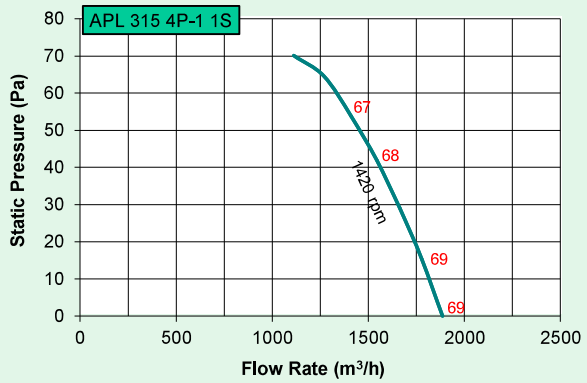
Model	□A	□B	ØD	ØE	ØF	H	M	Wt (kg)
APL 800 6P-3 1S	970	910	797	914	14.5	170	17	46.0
APL 800 8P-3 1S	970	910	797	914	14.5	170	17	45.0
APL 900 12P-3 1S	1070	1010	914	1115	14.5	210	22	55.0
APL 1000 12P-3 1S	1170	1110	1000	1140	14.5	210	22	61.0

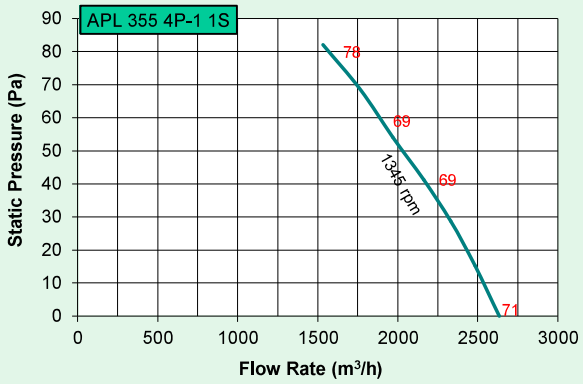
Technical Data - 50Hz

Model	Max Q (m^3/h)	Maximum Motor Input Power (W)	Motor Protection	Motor	N° Pole	Hz	Maximum Current (A)		Insulation Class	Lp (A)at 3m free discharge (dB (A))*	Speed (RPM)
							220V	400V			
APL 800 6P-3 1S	21687	1909	IP54	Three Phase	6	50	-	3.80	F	63	900
APL 800 8P-3 1S	15567	802	IP54	Three Phase	8	50	-	1.50	F	52	630
APL 900 12P-3 1S**	18459	690	IP54	Three Phase	12	50	-	2.20	F	49	440
APL 1000 12P-3 1S**	23794	890	IP54	Three Phase	12	50	-	1.90	F	50	420

- Model APL 800 - 1000 are not licensed by AMCA International.
* Inlet Lp(A) sound pressure levels at 3m are measured at free discharge in spherical free field condition, inlet Lp(A)(dB(A)) levels are not licensed by AMCA International.
** Please consult KRUGER for fan selection of this model.

Performance Data - 50 Hz





- Values shown are for inlet Lwi(A) sound power levels for installation type A: free inlet, free outlet. The A-weighted sound ratings shown have been calculated per AMCA International Standard 301.
- Performance certified is for installation type A – Free inlet, Free outlet.
- Performance ratings do not include the effects of appurtenances (accessories).
- Speed (RPM) shown is nominal. Performance is based on actual speed of test.

AXIAL FLOW FAN - direct driven

TDA - L
LONG CASED

Construction
Double flanged casing is produced in mild steel or galvanised Steel, the impeller having manually adjustable pitch blades is made of PPG, PAG or Aluminium.

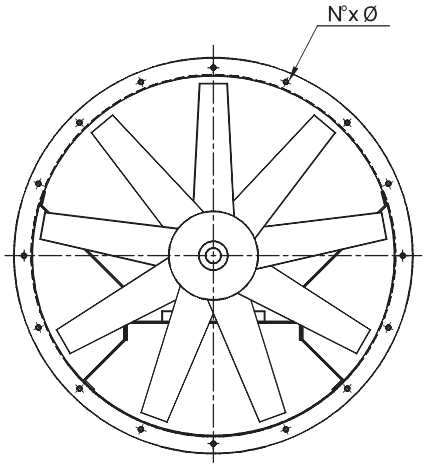
Finish
Painting or galvanised after manufacture is normal finish on all parts.

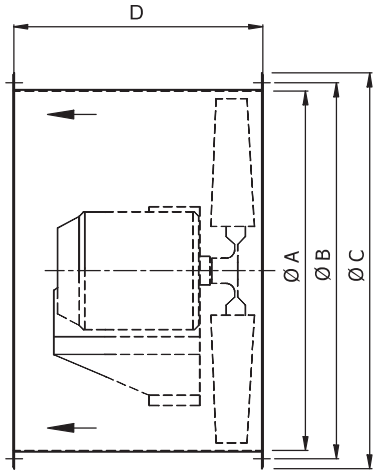
Operating Temperature
-20°C to +55°C

Motors
Totally enclosed Class 'F' motor, to a min. IP54 protection are fitted as standard. Standard motor up to 2.2kW are usually supplied on DOL starting, motor 3.0kW and above are star/ delta starting.

Airflow Direction
Air flow from impeller to motor is fitted as standard. Air flow from motor to impeller can be supplied upon request.

Option
Spark resistance construction in accordance with AMCA standard 99-0401-86-type C construction can be supplied upon request.





All Dimension in mm.

MODEL	A	B	C	D	N°	∅	Weight (kg)	Max.Motor* FrameSize
315	315	355	395	355	8	10	8	D71
355	355	395	435	355	8	10	10	D80
400	400	440	480	355	12	10	11	D90S
450	450	490	530	400	12	10	14	D90L
500	500	540	580	500	12	10	18	D90L
560	560	605	660	500	12	10	22	D112M
630	630	675	730	500	12	10	24	D112M
710	710	755	810	500	18	12	40	D112M
800	800	845	900	560	18	12	49	D132M

MODEL	A	B	C	D	N°	∅	Weight (kg)	Max.Motor* FrameSize
900	900	945	1000	630	18	12	66	D160M
1000	1000	1050	1100	630	24	12	73	D160M
1120	1120	1185	1250	900	24	12	135	D225M
1250	1250	1315	1380	1000	24	12	170	D250M
1400	1400	1465	1530	1120	32	14	220	D250M
1600	1600	1663	1730	1250	32	14	275	D250M
1800	1800	1856	1930	1400	32	14	335	D280M
2000	2000	2073	2130	1400	32	14	380	D315M
2250	2250	2330	2400	1535	36	18	430	D315M

* Please consult KRUGER if motor frame size is beyond the catalogue range.
• Note: Weight without motor and impeller.

The company is always improving and developing its products, therefore the company reserves the right of making changes to the illustrated products. Certified dimension can be provided upon request.

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General Instructions
(Propeller Fan)

APM Series

This manual is to assist the engineer to avoid the most common fan problems caused by improper storage, installation, operation and maintenance. **HANDLING AND MAINTENANCE SHOULD ALWAYS BE PERFORMED BY EXPERIENCED AND TRAINED PERSONNEL.**

RECEIVING, HANDLING AND STORAGE

Rough handling during shipment and improper storage can cause damage that is not noticeable until the fan is in operation. This can be avoided with proper storage and handling techniques.

Fan should be hoisted with slings placed around the fan housing. Touch up the scratch coated surfaces during lifting, to prevent corrosion to occur at this area. Store the fan in a clean and dry place, preferably indoor to ensure fan shaft, bearing and fan casing are protected against dust and corrosion. Do not store the fan in a location where it will be subjected to vibration. This can cause the internal surface to rub against each other and damage the bearings.

START-UP CHECK LIST

Before putting any fan into initial operation the manufacturer's instruction must be followed. Complete the following checklist to make sure that the fan is ready to run.

Lock out the primary and all secondary power sources.

Ensure that all fastener, particularly impeller fastener, are tight prior to start-up. Do not re-use locking fasteners.

Regularly check impeller fastener for tightness.

Spin impeller to see whether it rotates freely and is not grossly out of balance.

Inspect impeller for correct rotation for the fan design.

Properly secure all safety guards.

Switch on the electrical supply and allow the fan to reach full speed.

Check carefully for :- (1) Excessive vibration
(2) Unusual noise
(3) Proper amperage and voltage values

If any problem is indicated, SWITCH OFF IMMEDIATELY. Lock out the electrical supply, secure the fan impeller if there is a potential for wind milling. (impeller turning due to a draft through the system).
Check carefully for the cause of the trouble and correct as necessary.

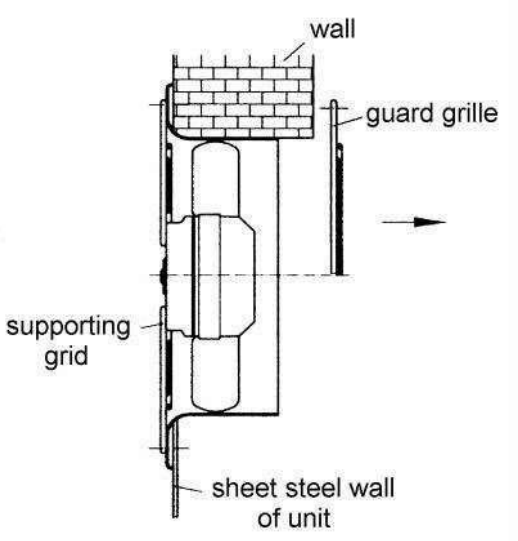
The fan may now be put into operation but during the first 8 hrs of running, it should be periodically observed and checked for excessive vibration and noise. Checks should be make of motor input current and motor & bearing temperature to ensure that they do not exceed manufacturer's recommendation. After 8 hrs of operation, the fan should be shut down to check the following items :-

(1) All set screws and hold-down bolts
(2) Bearing housing temperature

INSTALLATION

- Inlet and outlet ductwork should be free from obstructions.
- Avoid sharp bends on inlet or outlets.
- Do not use ductwork smaller in area than the fan.
- Flexible duct connections should be taut
- Ductwork connections should be well aligned.
- Inlet cones must be fitted to free inlet applications.
- Ensure that the fan orientation is correct for the required air flow direction.

IMPORTANT: External rotor motors only
All singled-speed three-phase fans must be wired in star only. If wired in delta they will burn out and motor warranty is avoid. Refer to wiring diagram for details.



ROUTINE MAINTENANCE

Maintenance should always be performed by experienced and trained personnel. Do not attempt any maintenance on a fan unless the electrical supply has been locked out or tagged out and the impeller has been secured.

Under normal circumstances, handling clean air, the system should require cleaning only about a year. However, the fan and system should be checked at regular intervals to detect any unusual accumulation.

The fan impeller should be specially checked for build-up of material or dirt which may cause an Imbalance with resulting undue wear on bearings and belt drives. A regular maintenance program should be established as needed to prevent material build-up.

Periodic inspection of the rotating assembly must be made to detect any indication of weakening of the rotor because of corrosion, erosion, or metal fatigue.

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KRUGER

General Instructions
(In-line Fan)

CFT-CPF-CCK-CPA Series

This manual is to assist the engineer to avoid the most common fan problems caused by improper storage, installation, operation and maintenance. **HANDLING AND MAINTENANCE SHOULD ALWAYS BE PERFORMED BY EXPERIENCED AND TRAINED PERSONNEL.**

RECEIVING, HANDLING AND STORAGE

Rough handling during shipment and improper storage can cause damage that is not noticeable until the fan is in operation. This can be avoided with proper storage and handling techniques.

Touch up the scratch coated surfaces during lifting, to prevent corrosion to occur at this area. Store the fan in a clean and dry place, preferably indoor to ensure fan shaft, bearing and fan casing are protected against dust and corrosion. Do not store the fan in a location where it will be subjected to high vibration.
This can cause the internal surface to rub against each other and damage the bearings.

START-UP CHECK LIST

Before putting any fan into initial operation the manufacturer's instruction must be followed. Complete the following checklist to make sure that the fan is ready to run.

- Lock out the primary and all secondary power sources.
- Make sure the foundation or mounting arrangement and the duct connections are adequately designed in accordance with recognized acceptable engineering practices.
- Check and tighten all hold-down (securing) bolts.
- Spin impeller to see whether it rotates freely and is not grossly out of balance.
- Inspect impeller for correct rotation for the fan design.
- Check belt drive alignment, use recommended belt tension.
- Check belt drive for proper sheave selection and make sure they are not reversed.
- Properly secure all safety guards.
- Switch on the electrical supply and allow the fan to reach full speed.

  Check carefully for :- (1) Excessive vibration
  (2) Unusual noise
  (3) Proper amperage and voltage values
  (4) Proper belt alignment

  If any problem is indicated, SWITCH OFF IMMEDIATELY. Lock out the electrical supply, secure the fan impeller if there is a potential for wind milling. (impeller turning due to a draft through the system).
  Check carefully the cause and correct as required.

The fan may now be put into operation but during the first 8 hrs of running, it should be periodically observed and checked for excessive vibration and noise. Check the motor input current and motor temperature to ensure that they do not exceed manufacturer's recommendation. After 8 hrs of operation, the fan should be shut down to check for the following items:

(1) All set screws and hold-down bolts
(2) Belt drive alignment
(3) Belt drive tension
(4) Bearing housing temperature

* For V-belt drive installation and belt tension, please refer to our general installation guide for Centrifugal Fan (IGB016.0/0600) for more information.

Installation Method

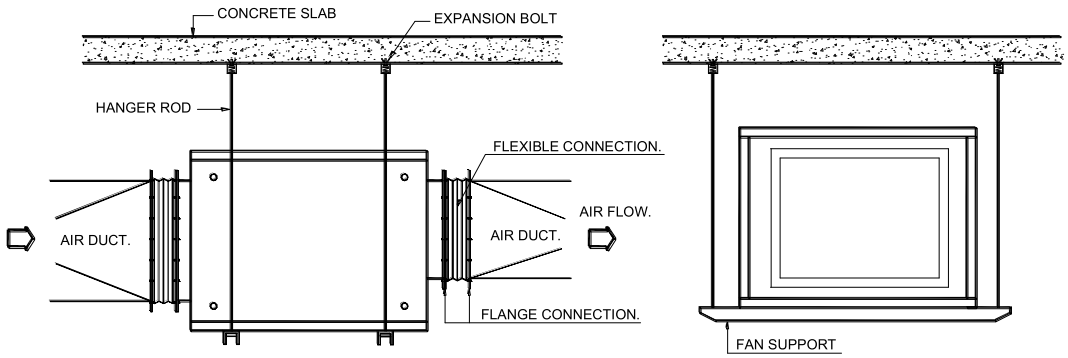

Fig.1

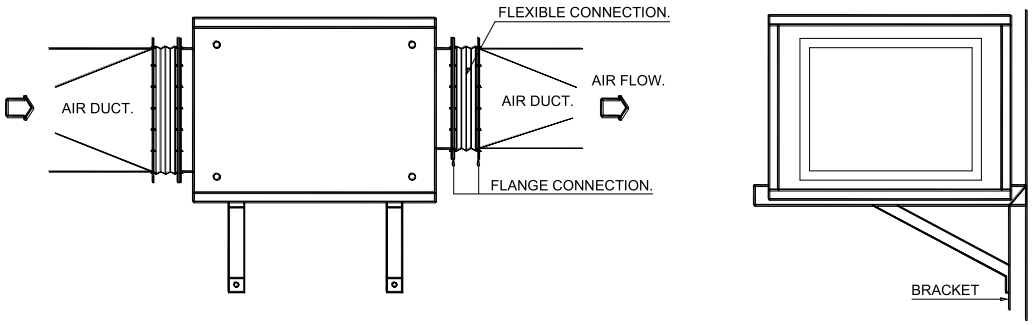

Fig.2

ROUTINE MAINTENANCE

Maintenance should always be performed by experienced and trained personnel. Do not attempt any maintenance on a fan unless the electrical supply has been locked out or tagged out and the impeller has been secured.

Under normal circumstances, handling clean air, the system should require cleaning only about a Year. However, the fan and system should be checked at regular intervals to detect any unusual accumulation.

The fan impeller sh.ould be specially checked for build-up of material or dirt which may cause an Imbalance with resulting undue wear on bearings and belt drives. A regular maintenance program Should be established as needed to prevent material build-up.

Periodic inspection of the rotating assembly must be made to detect any indication of weakening of the rotor because of corrosion, erosion, or metal fatigue.

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KRUGER

General Instructions
(Axial Flow Fan)

TDA, TDA-F, TDA-V, TBE, TDB, TDS

IGB010.E3/0806

This manual is to guide the users in the proper storage, installation, operation and maintenance procedures to ensure maximum equipment life and trouble-free operation. **HANDLING AND MAINTENANCE SHOULD ALWAYS BE PERFORMED BY EXPERIENCED AND TRAINED PERSONNEL.**

RECEIVING, HANDLING AND STORAGE

Rough handling during shipment and improper storage can cause damage that is not noticeable until the fan is in operation. This can be avoided with proper storage and handling techniques.

Fan should be hoisted with slings placed around the fan housing. Touch up the scratch coated surfaces during lifting, to prevent corrosion to occur at this area. Store the fan in a clean and dry place, preferably indoor to ensure fan shaft, bearing and fan casing are protected against dust and corrosion. Do not store the fan in a location where it will be subjected to vibration. This can cause the internal surface to rub against each other and damage the bearings.

START-UP CHECK LIST

Before putting any fan into initial operation the manufacturer's instruction must be followed. Complete the following checklist to make sure that the fan is ready to run.

Lock out the primary and all secondary power sources.

Make sure the foundation or mounting arrangement and the duct connections are adequately designed in accordance with recognized acceptable engineering practices and with the fan manufacturer's recommendations.

Check and tighten all hold-down (securing) bolts.

Check the fan assembly and bearings for proper grounding to prevent static electricity discharge.

Spin impeller to see whether it rotates freely and is not grossly out of balance.

Inspect impeller for correct rotation for the fan design.

Check belt drive or coupling alignment, use recommended belt tension.

Check belt drive for proper sheave selection and make sure they are not reversed.

Properly secure all safety guards.

Inlet and outlet damper (if any) must be maintain 60% air volume, totally closed should be avoided.

Switch on the electrical supply and allow the fan to reach full speed.

Check carefully for :-

(1) Excessive vibration
(2) Unusual noise
(3) Proper amperage and voltage values
(4) Proper belt alignment

If any problem is indicated, SWITCH OFF IMMEDIATELY. Lock out the electrical supply, secure the fan impeller if there is a potential for wind milling. (impeller turning due to a draft through the system). Check carefully for the cause of the trouble and correct as necessary.

The fan may now be put into operation but during the first 8 hrs of running, it should be periodically observed and checked for excessive vibration and noise. Checks should be make of motor input current and motor & bearing temperature to ensure that they do not exceed manufacturer's recommendation. After 8 hrs of operation, the fan should be shut down to check the following items :-

(1) All set screws and hold-down bolts
(2) Belt drive alignment
(3) Belt drive tension
(4) Bearing housing temperature

After 24 hrs of the satisfactory operation, the fan should be shut down, and the drive belt tension should be readjusted to recommended tension.

TROUBLE-SHOOTING

Fan is developing or emitting abnormal or excessive noise

	Possible cause	Remedy
Drive system	• Fan or motor sheave not properly tightened onto shaft • Misalign sheaves • Belt hitting Belt Guard • Belts are not tensioned enough and are too loose • Belts too tight • Belts wrong cross section • Belts worn • Belts oily or dirty • Belt guard is not properly fastened • Motor, motor base or fan not securely anchored or Secured	• Re-tightened the sheaves • Re-align the sheaves • Check fan & motor sheave alignment & belt tension • Increase the belt tension • Correct belt tension • Change to right type • Replace belts • Clean belts • Tighten the fasteners • Tighten the fasteners
Motor	• Lean-in cable not secure • Noisy motor bearings • Single phasing a 3 phase motor • Low voltage • Cooling fan striking shroud • Electromagnetic fault in motor • AC hum in motor or relay • Starting relay chatter	• Fasten the cable properly • Replace bearing • Check power supply • Check power supply • Check motor assembly • Replace motor
Fan Components	• Impeller loose on shaft • Impeller unbalance • Impeller not center in inlet or housing • Blades rotating close to structural member • Bearing defective or worn out • Bearing loose on bearing support or shaft • Foreign material inside bearing • Fretting corrosion between inner race and shaft • Bearing not sitting on flat surface • Rubbing noise between bearing seal and inner ring • Blades coinciding with an equal number of structural members	• Tighten impeller • Balance impeller • Adjust impeller to center of inlet or housing • Correct the running clearance • Replace bearing • Re-tighten bearing • Clean bearing • Replace bearing or shaft • Re-adjust bearing • Replace bearing

Fan is vibrating excessively

	Possible cause	Remedy
Impeller	• Impeller unbalanced due to deposits (dirt or grease) • Impeller unbalanced due to wear	• Clean impeller, rebalance the system • Replace impeller
Drive	• Unbalanced pulleys • Belts may vibrate excessively	• Balance the pulley or the system • Proper sheave alignment and adjust to correct belt tension

Required air volume not achieved

	Possible cause	Remedy
Impeller	• Impeller/inlet dirty or clogged • Improper running clearance • Improper blade setting • Impeller installed or running wrong direction • Incorrect speed of impeller because of: i) Wrong motor speed ii) Belt drive ratio not correct iii) Too high slip of V-belt iv) Wrong calibration of inverter	• Clean the impeller or inlet • Change to correct clearance • Adjust to correct angle • Change to correct rotation by changing poles of electrical feed line to motor i) Change motor or belt drive ii) Change belt drive iii) Increase tension of belts iv) Adjust inverter calibration
Duct System	• Shutters or dampers of the system are closed • Object obstructs fan or duct • Inlet guide vanes are partly close • Dampers closed • Registers closed • Leaks in supply duct • Obstructions near fan outlet or inlet • Sharp elbows near fan outlet or inlet • Improper designed turning vanes • The pressure losses of the duct system – suction or discharge side – are higher than calculated/expected try to find out at what duty point the fan actually is working! Pay special attention when using an axial fan • Insulating duct liner loose • Pressure resistance offered by the system higher than the design value • Fluid density higher than the design value • Actual system is more restrictive (more resistance to flow) than expected • Obstructed fan outlet inlets Elbows, cabinet walls or other obstructions restrict air flow. Inlet obstructions cause more restrictive systems but do not cause increased negative pressure readings near the fan inlet(s) Fan speed may be increased to counteract the effect of restricted fan inlet(s). Caution! Do not increase speed beyond the fan manufacturers recommendations • No straight duct at fan outlet (Fans which are normally used in duct system are tested with a length of straight duct at fan outlet. If there is no straight duct at the fan outlet, decreased performance may result. If it is not practical to install a straight section of duct at the fan outlet, the fan speed may be increased to overcome this pressure loss. Caution! Do not increase fan speed beyond the fan manufacturers recommendations.) • Projections, dampers or other obstruction in a part of the system where air velocity is high • Obstructions in high velocity air stream	• Open damper or IVC • Clear obstructed ducts • Open grill/diffuser damper • Open Damper • Open Register • Seal the Leakage • Clear obstruction • Redesign and change elbow • Redesign and change vanes • Modify duct design or try to eliminate turbulences by straighteners or increase fan speed to overcome unexpected losses (attention to available motor power and rpm limitation of fan)

Fan does not start or operate

	Possible cause	Remedy
Electrical Supply	• Blown fuses • Electricity turned off • Wrong voltage • Failure of one or two phases • Low voltage, excessive line drop or inadequate wire size	• Check fuses/circuit breakers • Check for switched off or disconnected • Check for correct power supply • Check for correct power supply • Check for correct wire size
Motor	• Motor not correctly connected • Load inertia too large for motor • Motor protection unit or switch are stopping as temperature are too high • Motor too small and overload protector has broken circuit	• Connect the motor according to the motor label • Change motor • Reduce temperatures, check and change insulation class, increase motor rating • Change motor
Drive System	• Broken belts • Loose pulleys	• Replace belt • Tighten pulley

Excessive air flow

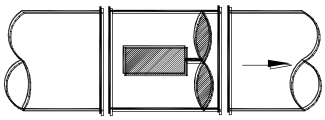
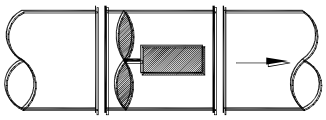
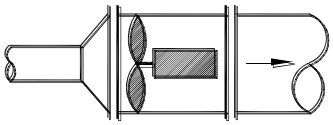
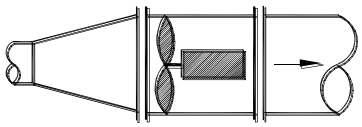
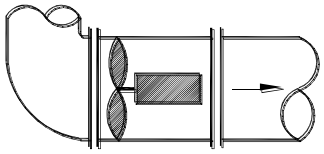
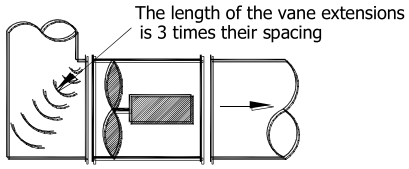
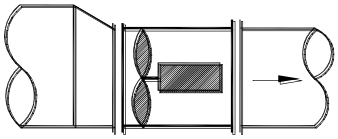
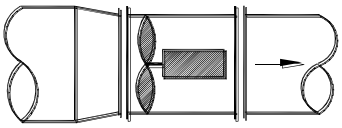
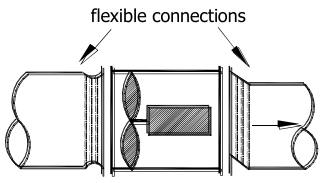
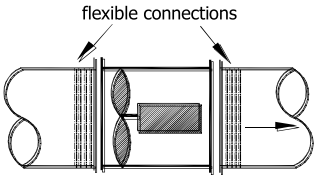
	Possible cause	Remedy
Duct System	• Pressure resistance offered by the system lower than the design value	
Gas Density	• Gas density higher than the design value	

High power absorption

	Possible cause	Remedy
Impeller	• Blade angle not set properly	• Adjust blade angle
Motor	• Faults in the motor windings • Motor power supply voltage lower than the value indicated on the identification plate	• Replace motor • Check with motor supplier
Fan	• Fan Air flow value lower than design value	
System	• Oversized ductwork • Filter(s) left out • Access door are open • Face and by-pass dampers oriented so coil dampers are open at same time by-pass dampers are open	• Redesign ductwork • Add in filter(s) • Close access door
Gas Density	• Calculated horsepower requirements based on light gas (eg. High temperature) but actual gas is heavy (eg. Cold start up)	
Fan selection	• Fan not selected at efficient point of rating	• Check selection

KRUGER

GUIDELINES FOR DUCTED AXIAL FLOW FAN INSTALLATION

INCORRECT	CORRECT
Motor upstream of impeller increases turbulence and noise 	Motor downstream from impeller minimizes turbulence and noise 
Abrupt inlet transition causes turbulence 	Gradual (1:7) expansion of the inlet duct avoids impeller turbulence 
Upstream radius elbow creates imbalance at inlet 	Square inlet elbow with extended trailing edge vanes delivers less turbulent airflow to fan inlet 
Assymmetrical transition creates imbalanced load on fan, with excess turbulence and noise 	Symmetrical transition balances load on fan, which minimizes turbulence and noise 
Slack or offset flexible connections causes turbulent air flow 	Taut, in-line flexible connections provide optional vibration isolation without creating turbulence 

Installation Method

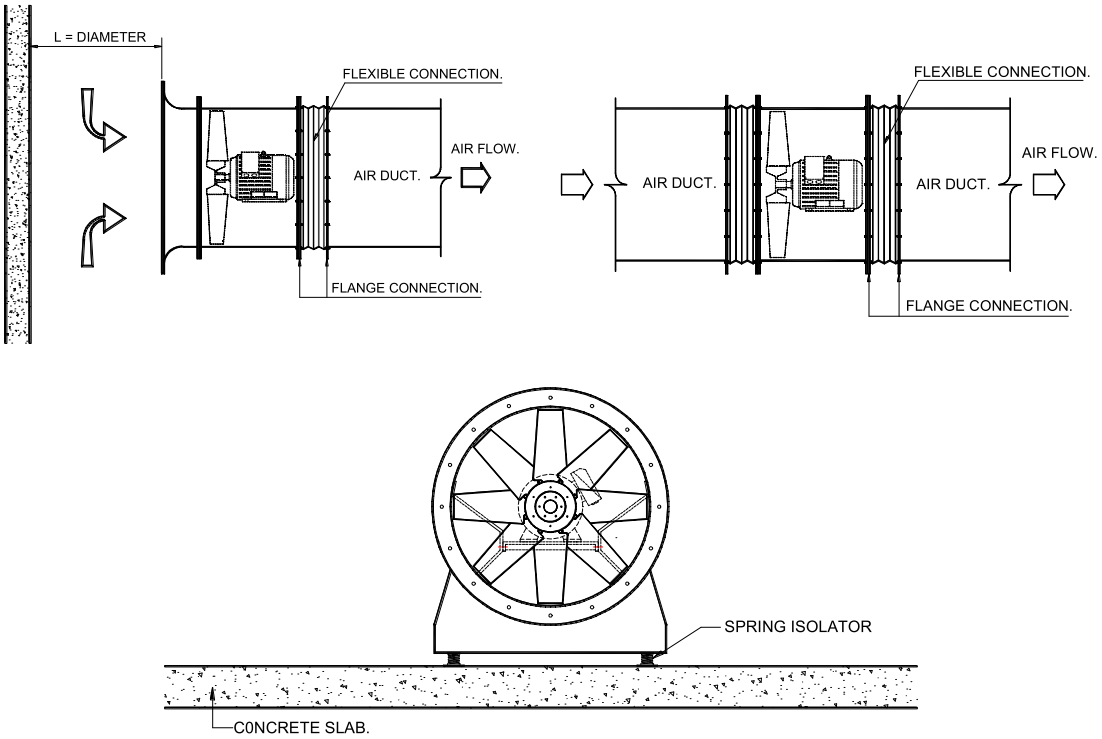


Fig. 1 - Floor Type

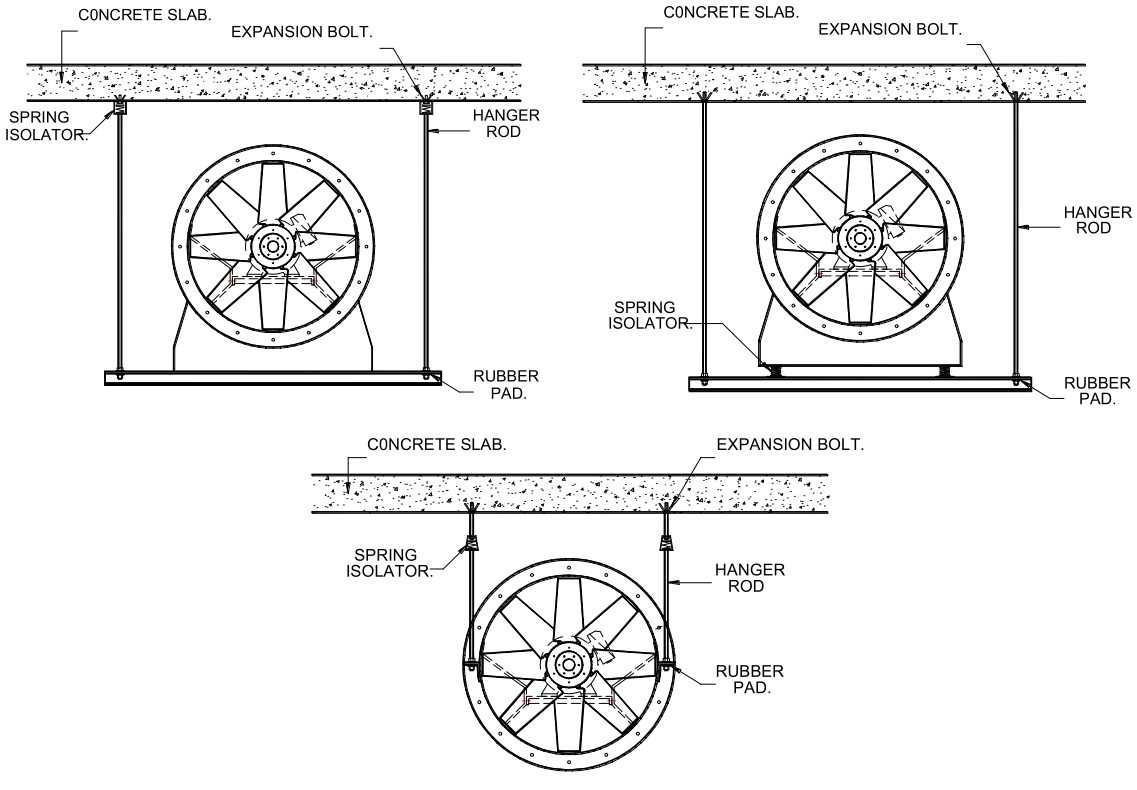
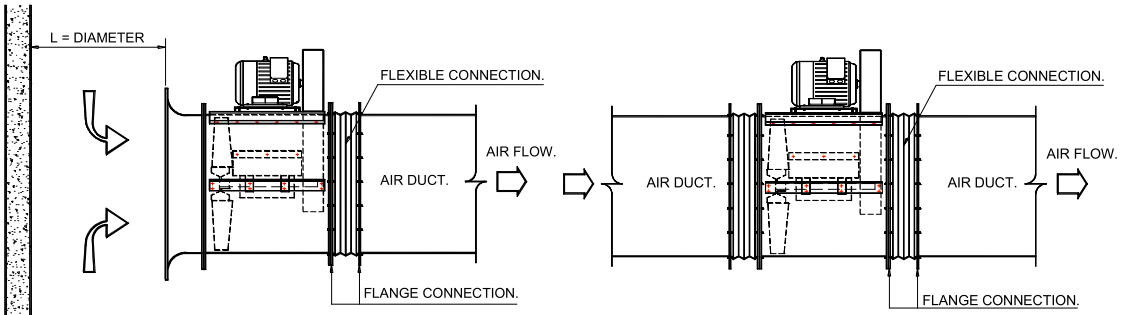


Fig. 2 - Ceiling Type

Installation Method



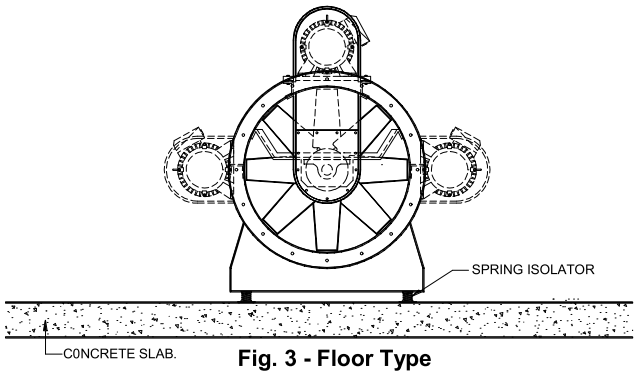
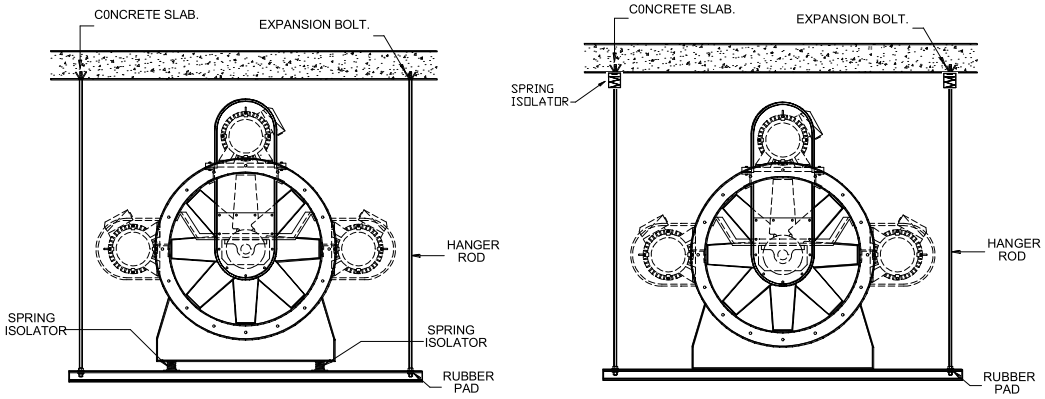


Fig. 3 - Floor Type



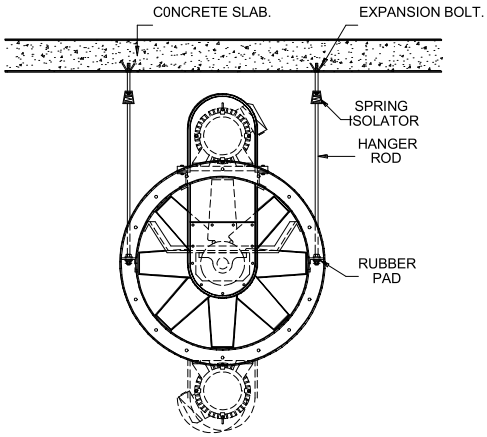


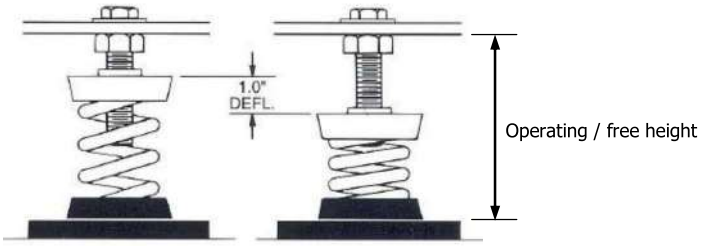
Fig. 4 - Ceiling Type

VIBRATION ISOLATOR INSTALLATION

- Choose proper isolator
  (Isolator can be selected from Kruger selection programme)

- Adjust deflection based on the selected isolator.
- Maintain the operating / free height at the same level through step 2.
- (The entire assembly must be levelled)

- Check all the deflection and operating / free height is properly maintained.



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Periodic inspection of the rotating assembly must be made to detect any indication of weakening of the rotor because of corrosion, erosion, or metal fatigue.

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KRUEGER

General Instructions

TSK II Series

G80

"KRUGER" domestic ventilator TSK II series are components to be installed in plants or machines to create ventilation systems, their purpose is to move gaseous liquids of the capacity and pressure as indicated. Correct installation is essential for health and safety of people during operation of the appliance, therefore the regulations indicated in these instructions must be observed and the mechanical protection must be prearranged.
If not properly installed the appliance may cause the risk of contact with the rotating fan, with consequent collision and abrasion. In addition, if it is not wired correctly, it may present risks related to electrical materials. Should the appliance be required to operate in isolation i.e. in laboratory test: it is necessary to block it appropriately and prearrange the protections to avoid contact with the rotating parts.
It is best to install the appliance as far as possible from areas usually occupied by people to avoid accessibility and to reduce exposure to noise.

Installation and Wiring instructions

The TSK II range of in-line duct extractor fans has been manufactured to rigorous standards of production laid down by the International Quality Standards ISO 9001. All the components have been checked and tested at the end of the manufacturing process.

We recommend you to check the following when you receive the product:

- Make sure is the correct size and model.
- Details such as voltage, frequency, performance on the rating labels are those you require.

Installation

- This unit must not be installed outside, unless covered by a suitable weatherproof enclosure.
- For installation, a robust mounting foot is available as an accessory.
- The fan should be installed to ensure minimum vibration and noise transmission to surrounding ductwork and building frames. Anti-vibration mountings and sound attenuating accessories are available. Please contact your local distributor.
- The fan should always be installed so that safe operation and maintenance can be ensured.

Electrical connection

- Before installation and Wiring, ensure the main electrical supply is disconnected!
- Ensure that the voltage and frequency of the electrical supply match the information stated on the name plate of the unit (maximum recommended tolerance of voltage (V) and frequency (Hz) ± 5%)
- Connect the electrical supply in accordance with the electrical wiring diagram in Fig 1.
- Before operation, check all connections are correct and there are no obstructions to the airflow.
- On connecting the electrical supply, ensure the direction of rotation and airflow correspond with the direction of airflow/rotation arrows (sited on unit)

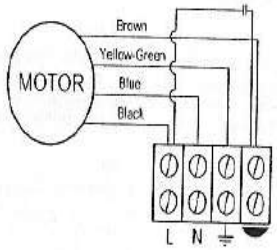
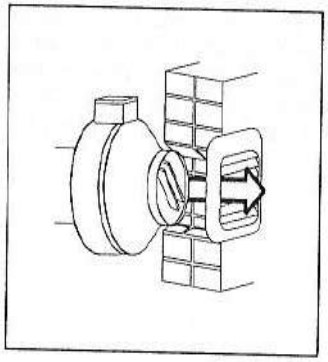


Fig. 1

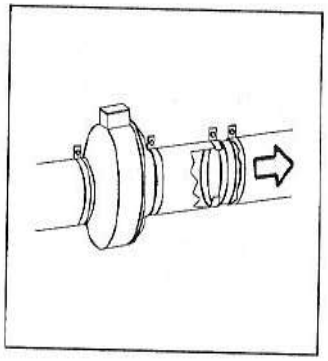
Important Safety Information

- The installation should always be carried out in accordance with all current applicable Standards to the country in which it is installed.
- The installation should always be carried out by a suitably qualified and competent person.
- These fans are not for stand-alone use. They are designed to be incorporated into ducted systems, machines or where safe operation has been ensured by providing applicable protection to moving parts.
- Do not use this product in, or to extract from, potentially hazardous or explosive atmospheres.

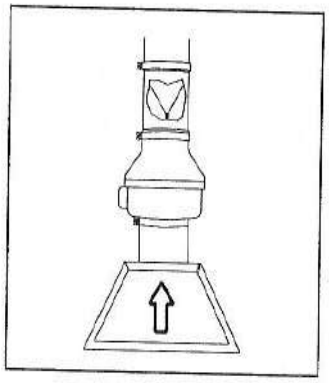
Installation Methods



1. At the end of the duct. (with a protective grille on the outside wall.)



2. In the middle of the duct. (with a pipe clamp and backdraft shutter install near the outlet end)



3. For intake above a hood. (with pipe clamp and backdraft shutter fitted at the outlet end of the unit)

Maintenance

Before inspection or repair, ensure that the unit is disconnected from the mains electrical supply. Avoid excessive accumulation of dust and dirt on the motor. The fan impeller should be cleaned at least once a year to ensure trouble free operation. Do not clean the unit with strong detergents or cleaning fluids. Use a damp (not wet) cloth only for cleaning.

KRUGER

KRUGER VENTILATION INDUSTRIES (NORTH INDIA) PVT. LTD.

QUOTATION | **Document No.** KNI/MKTG/F/04/A | **Rev.no** - 01

MEMBER

Ref No : [redacted]
Date : [redacted]
M/S : [redacted]

A. TECHNICAL ANNEXURE:

Sr. No	Capacity (CFM)	Static pressure (mmwg)	Block	Floor	Location	Fan Application	Fan Type	Fan Casing MOC	Fan Model	Fan RPM	Motor							Qty.	Fan Perfprmance & Design Standard	Balancing Grade	Impeller / Wheel Diameter (In MM)	Static Weight of fan along with Motor (Approx in KG)	Dynamic Weight of fan along with Motor (Approx in KG)
											KW	Pole	Ph	EFF Grade	Ins	Prot	Motor Make						
1	18000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-5, upper RHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/10**	960	7.5	6	III	IE2	H	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**1250 MM**	**364.5**	**437.4**
2	18000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-5, upper RHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/10**	960	7.5	6	III	IE2	H	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**1250 MM**	**364.5**	**437.4**
3	4500	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- Pump room, upper LHS	Fresh Air Supply	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/14**	1450	1.5	4	III	IE2	F	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**710 MM**	**85**	**102**
4	6000	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- Pump room, upper LHS	Normal Clean Air Exhaust	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/16**	1450	2.2	4	III	IE2	F	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**710 MM**	**95**	**114**
5	4000	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement S.T.P. Areazone-5, upper LHS	Fresh Air Supply	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/12**	1450	1.5	4	III	IE2	F	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**710 MM**	**85**	**102**
6	5000	30	CCC Block	Combined Basement Area (C&C & Audi)	Basement S.T.P. Areazone-5, upper LH	Normal Clean Air Exhaust	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 710/12AA/7-7/14**	1450	1.5	4	III	IE2	F	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**710 MM**	**85**	**102**
7	28000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-4, LHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/18**	960	11	6	III	IE2	H	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**1250 MM**	**392**	**470.4**
8	28000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-4, LHS	Smoke Exhaust (250 Deg C @ 2 Hrs)	Direct Driven Tube Axial Fan With Fire Rated Motor (250 Deg C @ 2 Hrs)	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/18**	960	11	6	III	IE2	H	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**1250 MM**	**392**	**470.4**
9	28000	40	CCC Block	Combined Basement Area (C&C & Audi)	Basement Area- zone-4, LHS	Fresh Air Supply	Direct Driven Tube Axial Fan	MS With PR-12 Powder Coated Tube Casing With aluminium Impeller	**TDA 1250/25BJ/6-6/18**	960	11	6	III	IE2	F	IP55	Havells	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**1250 MM**	**360**	**432**
10	2200	30	C & C Block	Ground Floor	Service Counter & Pantry	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CSD 400 6P-3 1SC**	960	1.5	6	III	STD	F	IP54	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**400 MM**	**55**	**66**
11	1000	30	C & C Block	Ground Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
12	1000	30	C & C Block	Ground Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
13	2000	30	C & C Block	Ground Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 400 4P-1 1S**	1355	0.268	4	I	STD	F	IP54	-	**2**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**400 MM**	**9**	**11**
14	1000	30	C & C Block	1st Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
15	1000	30	C & C Block	1st Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
16	1000	30	C & C Block	1st Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	1420	0.112	4	I	STD	F	IP54	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**7**	**8.5**
17	500	30	C & C Block	1st Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Circular Inline Fan	GSS Cabinet With Non-stalling backward curved impeller	**TSK II 315L**	2600	0.24	2	I	STD	B	IP44	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**8**	**9.6**
18	150	-	C & C Block	1st Floor	Toilet	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	1300	0.018	4	I	STD	B	IP44	-	**2**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**200 MM**	**1.8**	**2.16**
19	1000	30	C & C Block	2nd Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
20	1000	30	C & C Block	2nd Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
21	1000	30	C & C Block	2nd Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	1420	0.112	4	I	STD	F	IP54	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**7**	**8.5**
22	500	30	C & C Block	2nd Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Circular Inline Fan	GSS Cabinet With Non-stalling backward curved impeller	**TSK II 315L**	2600	0.24	2	I	STD	B	IP44	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**8**	**9.6**
23	1000	30	C & C Block	3rd Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
24	1000	30	C & C Block	3rd Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
25	1000	30	C & C Block	3rd Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	1420	0.112	4	I	STD	F	IP54	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**7**	**8.5**
26	200	-	C & C Block	3rd Floor	Store Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	1300	0.018	4	I	STD	B	IP44	-	**2**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**200 MM**	**1.8**	**2.16**
27	1000	30	C & C Block	4th Floor	Toilet (HE)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
28	1000	30	C & C Block	4th Floor	Toilet (SHE & HANDI)	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7 4P-1 3SY**	1200	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
29	1000	30	C & C Block	4th Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	1420	0.112	4	I	STD	F	IP54	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**7**	**8.5**
30	600	30	C & C Block	5th Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-7T 4P-1 3SY**	1150	0.245	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**24**	**28.8**
31	200	-	C & C Block	5th Floor	Toilet	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	1300	0.018	4	I	STD	B	IP44	-	**5**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**200 MM**	**1.8**	**2.16**
32	1000	30	C & C Block	5th Floor	Electrical Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	High grade steel wall plate sheet with painted finish & metallic sickle Blade impeller	**APL 315 4P-1 1S**	1420	0.112	4	I	STD	F	IP54	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**315 MM**	**7**	**8.5**
33	150	-	C & C Block	5th Floor	Store Room	Normal Clean Air Exhaust	Direct Driven Wall Mounted Propeller Fan	GSS mlounting plate With aluminium blades	**APM 200**	1300	0.018	4	I	STD	B	IP44	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**200 MM**	**1.8**	**2.16**
34	1200	30	C & C Block	5th Floor	Pantry	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 9-9 4P-1 3SY**	1300	0.35	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**225 MM**	**27**	**32.4**
35	1400	30	C & C Block	5th Floor	Kitchen	Normal Clean Air Exhaust	Direct Driven Forward Curved Rectangular Inline Fan	GSS Cabinet With GSS wheel / Impeller	**CCE 10-8 4P-1 3SY**	1150	0.55	4	I	STD	F	IP20	-	**1**	**As per "AMCA"**	ISO1940 and AMCA 204/3 - G2.5 quality grade which is better than Gr:G6.3 and same shall be mentioned in fan test certificate at the time of dispatch	**250 MM**	**33**	**39.6**
																		TOTAL	**42**				

systemair

TECHNICAL DATA SHEET

FIRE DAMPER (MOTORIZED)

S.No.	DESCRIPTION	DETAILS
1	MAKE	SYSTEMAIR INDIA PVT. LTD.
2	SIZE	NECK- AS PER SITE REQUIRMENT
3	PRODUCT NAME	FIRE DAMPER (MOTORIZED) WITH 165 MM CASING (WITHOUT SLEEVE)
4	MODEL	WGD
5	CERTIFICATION	CBRI APPROVED 90 MINS FIRE RATING, TESTED AS PER UL555, 2005
6	FIRE RATING	90 MINUTES
7	MOUNTING	DUCT COLLAR
8	BUSH	BRONZ BUSH WITH SELF LUBRICATION
9	BLADE CONSTRUCTION	SINGLE LEAF V-TYPE
10	MATERIAL OF DAMPER	GALVANIZED STEEL
11	COATING	ZINK COATING (120 GSM)
12	THICKNESS OF MATERIAL	FRAME -16 SWG GI SHEET LOUVER/BLADE -16 SWG GI SHEET
13	LINKAGE	M.S IS-2062 (3 MM THICK PLATE)
14	ACTUATOR	BELIMO MAKE SPRING RETURN ROTORY TYPE ON/OFF ACTUATOR
15	CONTROL PANEL	CONTROL PANEL WITH TEMPERATURE SENSOR. SENSOR WORK ON 74 DEGREE TEMP.
16	TYPE OF DAMPER	MOTORIZED
17	WIDE	MINIMUM SIZE -300 X 300 MM (NECK) MAXIMUM SIZE 1500 X 1200 MM (NECK) SIZE ABOVE THAN MAX WILL BE IN PARTITION

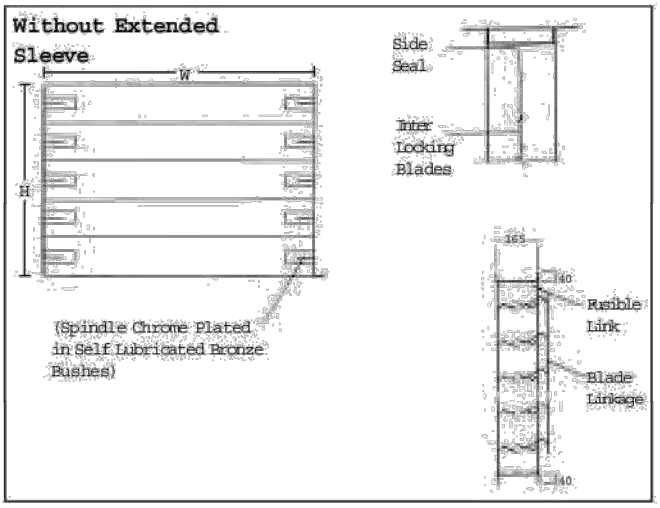
Fire & Smoke Dampers - Model WGD

Introduction

The Ravistar range of Fire & Smoke Dampers has been specifically designed to be positioned within the duct system to prevent the free passage of smoke & fire. The range is constructed from heavy gauge galvanised iron sheet having multiple opposed blade construction. The blades are fitted with crome plated spindles operating in self lubricating sintered bronze bushes with stainless steel side seal gaskets to prevent spread of smoke & fire. The operating linkage is fully enclosed. **These Dampers are fire tested by CBRI Roorkee for 90 minutes fire rating as per UL555-1995.**

Description

GI sheet construction fire & smoke dampers with flat V type opposed blade operation, 16 swg G.I. blade 150mm wide, 16 swg G.I. frame 165mm wide, chrome plated spindle, self lubricating bronze bushes, blade. Linkage fully enclosed, stainless steel side seal gaskets on the sides.



Features

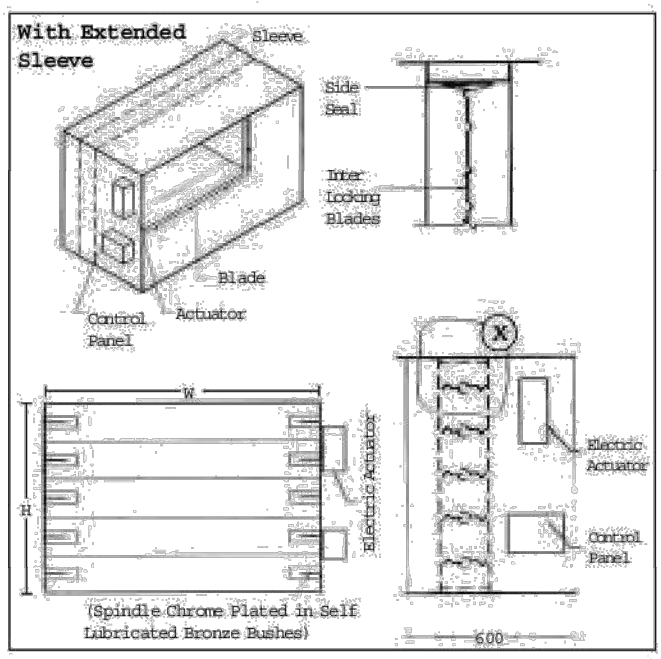
- Robust & fully welded construction.
- Heavy duty interlocking blades.
- Fully enclosed blade linkage mechanism.
- Stainless steel side seal gaskets.
- Self lubricating sintered bronze bushes.

Control Options

Fusible link, solenoid operation and electric actuators.

Dimensions and Types

The dampers are available with and without extended sleeve of G.I. steel. The dampers without extended sleeve are with G.I. flanged frame suitable for duct mounting. The dampers with extended sleeve are with G.I. frame positioned in G.I. sleeve suitable for wall mounting.



Specification

Model WGD - The casing is constructed of 16 swg G.I. sheet, the blades are flat V type formed from 16 swg G.I. sheet and fixed with chrome plated spindles housed in self lubricating sintered bronze bushes. The drive mechanism consists of galvanised steel flat linkage system completely encased & outside the air stream.

Control Options

Ravistar range of fire & smoke dampers are available with following control options :-

1. **With Fusible Link and Spring Mechanism**
   The damper is held open by a replaceable fusible link rated at 74 C (U.L. stamped). In the event of the increase in temperature the fusible link shall melt & the damper shall close shut with spring action.

2a. **With on/off actuator without spring return, control panel and temp-sensor.**
   The damper is held open by the 24V Ac/Dc actuator. The actuator shall close the damper on receiving a signal

from the smoke detector/fire panel or temperature sensor through the control panel which is field mounted or mounted on the casing if required. The power supply required is 220V A.C.

2b. **With on/off spring return actuator, control panel & temp. sensor.**
The control is same as in item (2a) above except that the actuator is of the spring return type and in case of power not available during smoke/fire condition the spring actuator shall ensure the closure of the damper.

3. **Solenoid**
The blades are held in open position by solenoid against spring loaded linkage mechanism. On receiving signal the solenoid actuates and releases the blades to shut off.

Details of Control Options

1. Rating of Electric Actuator

	Actuator torque	Damper Area
Spg. Return	7 NM	upto 1.0 m²
	16 NM	upto 2.4 m²
W/o Spg.	10 NM	upto 1.2 m²
Return	15 NM	upto 2.4 m²

2. Solenoid Mechanism

Light Duty - upto 0.8 Mt²
Heavy Duty - upto 2.4 Mt²

Ordering

Model	Type	Size W x H	Location of actuator
W G D	With sleeve	1000x600	LH/RH Entry Air

Legend
Type : W G D

Smoke and Fire Damper Panel

Smoke and fire damper panel is designed to operate motorised Damper. It closes the damper in case the temperature in the duct increases more than 74°C or it gets smoke signal from the smoke sensor. The panel can also operate Damper by external signal from Fire panel etc.

The panel has been provided with audio and visual alarm and has independent indicators to indicate Damper open, Damper close, Fault, Power ON and audio alarm. The panel is also provided with test/reset push button.

One set of 5Amp. 230V AC change over contacts is provided. which can be used to trip off the AHU fan and operate external audio alarm in case of fire or smoke.

Specification

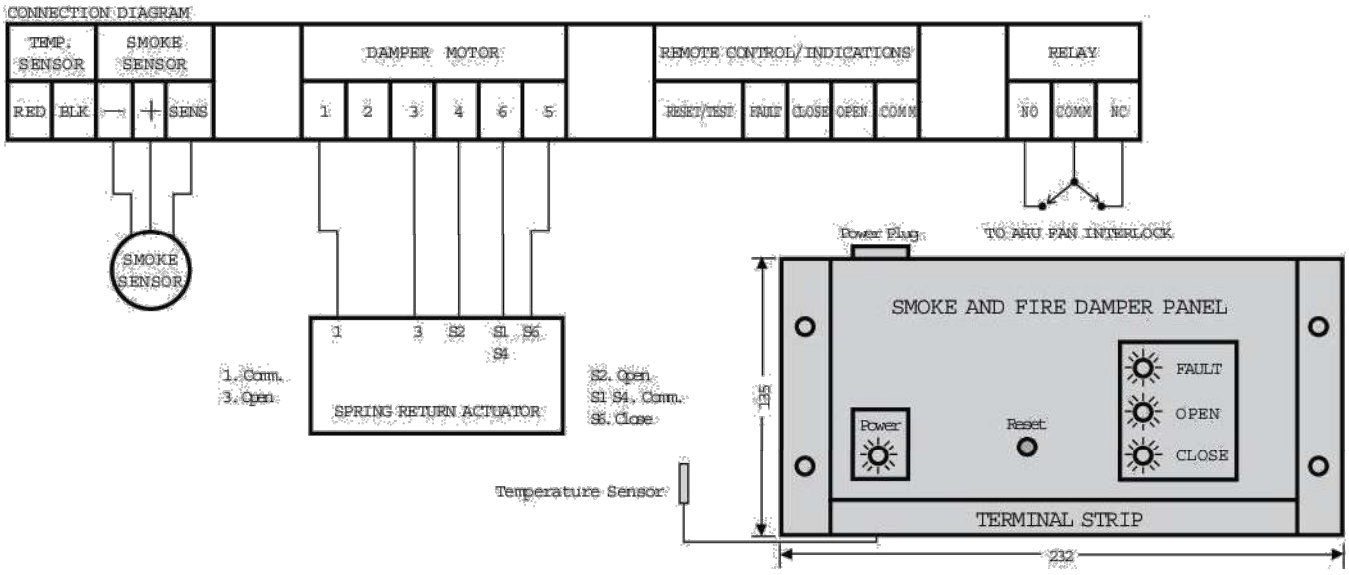
Input voltage : 230V ± 10% 50 Hz AC
Power consumption : 10W max.
Fault Temperature : 74 ± 5°C

Indications/Controls

Power : Indicate that the power / supply has been connected to the panel and ready for operation.
Fault : Indicates when smoke is sensed by smoke sensor or the temperature in side the duct increases more than the fault temperature.
Open : Indicates when damper is open.
Close : Indicates when damper is close.
Reset/Test : When the reset/test push button is pressed continuously the damper get closed and reopen when released. It also reset fault alarm when fault has been cleared.

Typical Connection Details for Control Panel

Connection Diagram for 24V AC Spring Return Actuator



dsUnzh; Hkou vuqla/kku laLFkku

CENTRAL BUILDING RESEARCH INSTITUTE

(A CONSTITUENT ESTABLISHMENT OF CSIR)

ROORKEE - 247 667, U.P. (INDIA)

Dr. T. P. SHARMA

Dy. Director & Head

FIRE RESEARCH LABORATORY

Tel. : 01332 - 72235, 72630, 82352, 82379
Fax : 01332 - 72272, 72543 Gram : BILDSERCH
E-mail : tps@csbri.ren.nic.in

M/s Ravistar India Pvt. Ltd.
F-56, Kalkaji,
New Delhi-110019

No. 212(1)/FR/2000
September 19, 2000

Dear Sir,

This refers to the fire endurance & hosestream on your specimen (2nos) of Ravistar Multiflap (7Nos) fire damper which were carried out as per UL:555-1995 on September 15, 2000 and September 19, 2000 in presence of your Shri R.K. Khosla, Managing Director.

The Multiflap (7nos) fire damper of opening size 1000mm x 1000mm were mounted vertically on September 15, 2000 and September 19,2000 in the Wall Furnace with the upstream side facing the furnace (fusible link was placed to the exposed face) and downstream side facing the furnace (fusible link was placed to the unexposed face) respectively. The furnace was regulated according to standard heating condition as specified in UL:555-1995.

During the fire endurance & hose-stream evaluation the maximum gap in between the flaps was measured on both the specimen of Ravistar multi-flap fire damper and found the permissible limit as per clause 10 of UL:555-1995.

The Ravistar multi-flap (7nos) fire damper specimen (2nos) supplied by M/s Ravistar India Pvt. Ltd., New Delhi was able to successfully withstand the standard fire for 90 minutes rating in the upstream & downstream position.

It is to be noted that Institute's responsibility is only limited to the technical evaluation of multiflap (7nos) fire damper specimen installed by the firm. It is in no way responsible for any procedural, legal commercial and operational matters.

Thanking you,

Yours faithfully

(T.P. Sharma)

(Suvir Singh) Co-Investigator

(S.B. Gupta) Evaluation Officer

(A.S. Srivastava) Evaluation Officer

TECHNICAL SPECIFICATION

UNIT QTY - 1 NO

Submit QAP of AHUs

Fan CFM	
11400	28.5 TR

SPECIAL INSTRUCTIONS	ITEM BY CUSTOMER
1- MOTOR WILL HAVE IE-2. 2- LIGHT , LIMIT SWITCH , WIRE GUARD & VIEW GLASS WILL BE PROVIDED IN FAN SECTION ONLY. 3- MANUALLY OPERATED ALL DAMPER IN ALUMINIUM CONSTRUCTION. 4- DX COIL TUBE TYPE 0.5MM THK (IGT TYPE). 5- DX COIL HAVE SUCTION LINE SIZE: 28.58mm & LIQUID LINE SIZE: 15.88mm 6- DX COIL HAVE: 03 NO. OF DISTRIBUTORS. 7- REFRIGERANT USE: R41A & OUTDOOR MAKE: Lg 8- COIL & FILTER WILL BE DESIGN@ 500 FPM. 9- 13 MM THK CLOSED CELL NITRILE INSULATION WILL BE PROVIDED IN TRAY SECTION ONLY. 10- Noise @ 1.5 m -63 dB	1. NIL

Outer Skin	Inner Skin	Panel Thk	Insulation	Profile	Frame Work
0.6 PRE COATED GI	0.6 PLAIN GI	25±2MM	40±2KG/M³ CFC FREE PUF	THERMAL BREAK	Aluminium
Unit Colour	**Panel const.**	**Unit Base**	**Suspension arrangment**	**Type of unit**	**Filter Make**
ORANGE	DOUBLE SKIN	G.S.S	NA	FLOOR MOUNTED	SPECTRUM/ZECO

Supply Air Fan	Static Pressure-mmwg	r.p.m	Outlet Velocity(M/S)	Fan Discharge	Fan Make
FORWARD-630	50	572	8.4	TRS1100	KRUGER
Motor Kw	**Pole**	**Motor RPM**	**Frame**	**Motor Mounting**	**Motor Make**
5.5	4	1440	132	90-132	CROMPTON
Motor Pulley		**Fan Pulley**		**Belt Size**	**Isolator-Model/Qty**
125X2SPA		315X2SPA		60SPA#2 NOS	STANDARD
Motor Phase	3 PH				

Cooling Coil	1NO-DX COIL				
FH	**FL**	**RD**	**FPI**	**Area (Sqft.)**	**Tube Size(OD)**
1219.2	1738	6	12	22.8	3/8"-IGT
Heating Coil	**NO**				
FH	**FL**	**RD**	**FPI**	**Area (Sqft.)**	**Tube Size(OD)**

Coil	Tube Material	Tray Material	Fin Material	Fin Coating	Header Material
	COPPER	SS-304-20G	ALUMINIUM	BLUE-HYDRAUFILLIC	CU

Air Filter Type	Flange/ Box	Qty	Size	eff.	EU
PRE FILTER	BOX TYPE	6	610X610X50	90% DOWN TO 10 MICRON	EU-4

Air Filter Type	Flange/ Box	Qty	Size	eff.	EU

Air Filter Type	Flange/ Box	Qty	Size	eff.	EU

Unit Condition -	Assembled	SKD		
Packing- crate	wooden Pallet		Polythene	Flexible conn.
CONSULTANT:-				FIRE RETARDENT

CLIENT	PROJECT	MODEL
		ZDS-120

Revision	Description	Rev Date	DRG. NO.	DRN. BY	DATED
A					
B			Appd by	ZECO AIRCON LIMITED	
C					

TECHNICAL SPECIFICATION

UNIT QTY - 2 NOS

Fan CFM	
4800	12 TR

SPECIAL INSTRUCTIONS	ITEM BY CUSTOMER
1- MOTOR WILL HAVE IE-2. 2- LIGHT , LIMIT SWITCH , WIRE GUARD & VIEW GLASS WILL BE PROVIDED IN FAN SECTION ONLY. 3- MANUALLY OPERATED ALL DAMPER IN ALUMINIUM CONSTRUCTION. 4- DX COIL TUBE TYPE 0.5MM THK (IGT TYPE). 5- DX COIL HAVE SUCTION LINE SIZE: 22.22mm & LIQUID LINE SIZE: 12.70mm. 6- DX COIL HAVE: 01 NO. OF DISTRIBUTOR. 7- REFRIGERANT USE: R410A & OUTDOOR MAKE: Lg 8- COIL & FILTER WILL BE DESIGN@ 500 FPM. 9- 13 MM THK CLOSED CELL NITRILE INSULATION WILL BE PROVIDED IN TRAY SECTION ONLY. 10- Noise @ 1.5 m for -65 dB	1. NIL

Outer Skin	Inner Skin	Panel Thk	Insulation	Profile	Frame Work
0.6 PRE COATED GI	0.6 PLAIN GI	25±2MM	40±2KG/M³ CFC FREE PUF	THERMAL BREAK	Aluminium
Unit Colour	**Panel const.**	**Unit Base**	**Suspension arrangment**	**Type of unit**	**Filter Make**
ORANGE	DOUBLE SKIN	G.S.S	NA	FLOOR MOUNTED	SPECTRUM/ZECO

Supply Air Fan	Static Pressure-mmwg	r.p.m	Outlet Velocity(M/S)	Fan Discharge	Fan Make
FORWARD-18X18	50	864	8.5	TRS640	KRUGER
Motor Kw	**Pole**	**Motor RPM**	**Frame**	**Motor Mounting**	**Motor Make**
3.7	4	1425	112	90-112	CROMPTON
Motor Pulley		**Fan Pulley**		**Belt Size**	**Isolator-Model/Qty**
112X2SPA		180X2SPA		33SPA#2 NOS	STANDARD
Motor Phase	3 PH				

Cooling Coil	1NO-DX COIL				
FH	**FL**	**RD**	**FPI**	**Area (Sqft.)**	**Tube Size(OD)**
812.8	1098	6	12	9.6	3/8"-IGT
Heating Coil	**NO**				
FH	**FL**	**RD**	**FPI**	**Area (Sqft.)**	**Tube Size(OD)**

Coil	Tube Material	Tray Material	Fin Material	Fin Coating	Header Material
	COPPER	SS-304-20G	ALUMINIUM	BLUE-HYDRAUFILLIC	CU

Air Filter Type	Flange/ Box	Qty	Size	eff.	EU
PRE FILTER	BOX TYPE	2	610X610X50	90% DOWN TO 10 MICRON	EU-4
		2	305X610X50		

Air Filter Type	Flange/ Box	Qty	Size	eff.	EU

Air Filter Type	Flange/ Box	Qty	Size	eff.	EU

Unit Condition -	Assembled	SKD		
Packing- crate	**wooden Pallet**		**Polythene**	**Flexible conn.**
CONSULTANT:-				FIRE RETARDENT

CLIENT	PROJECT	MODEL
		ZDS-50

Revision	Description	Rev Date	DRG. NO.	DRN. BY	DATED
A					
B			Appd by	ZECO AIRCON LIMITED	
C					

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

Project Name:
Quote Number:
Date:

Contact
Company:
Address:
Telephone:
Fax:
Email:

Notes:

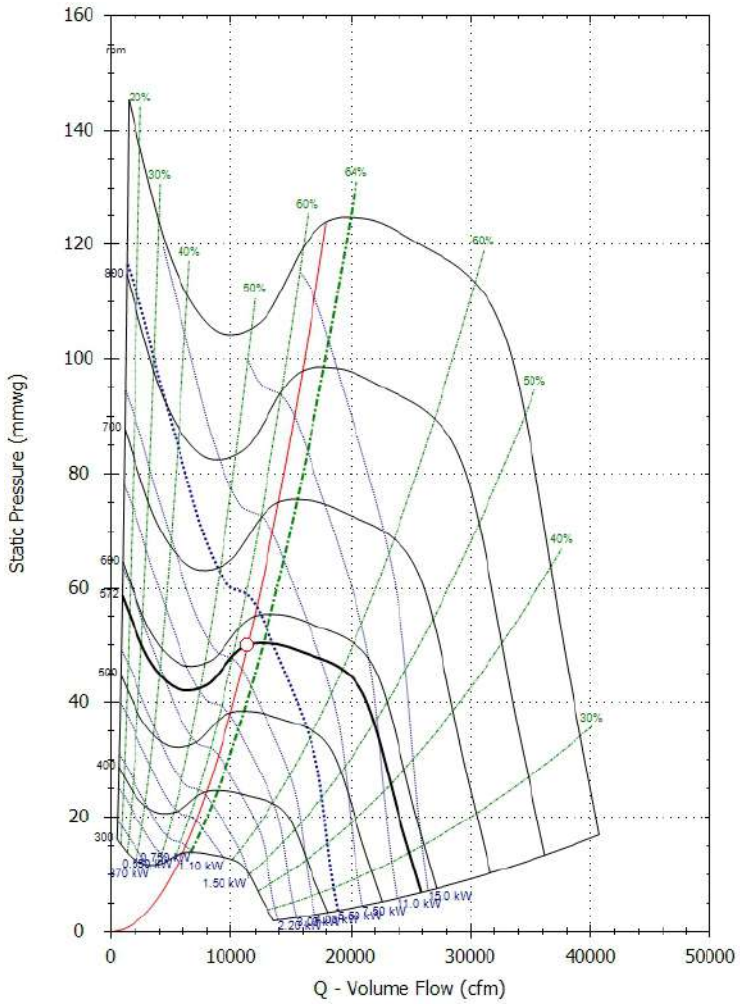
Reference	Qty	Model	Normal Diameter (mm)	Air Volume (m3/s)	Total Pressure (Pa)	Static Pressure (Pa)	Velocity (m/s)	Absorbed Power (kW)	Total Efficiency (%)	Static Efficiency (%)	Lw dB(A)	Lp dB(A) @ 1.5m	Fan Speed (rpm)	Motor kW/Pole/V/Ph/Hz
FDA630	1	FDA630/CM (I)	630	11,400	54	50.0	8.41	4.57	62.8	57.7	83	73	572	D132 5.50/6/400/3/50
KAT 18-18	1	KAT 18-18/SL (I)	450	4,800	54	50.0	8.51	2.22	54.5	50.1	86	75	864	D132 3.00/6/400/3/50

Date	09-12-2022
Company	
Attention	
Project	
Reference	FDA630

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

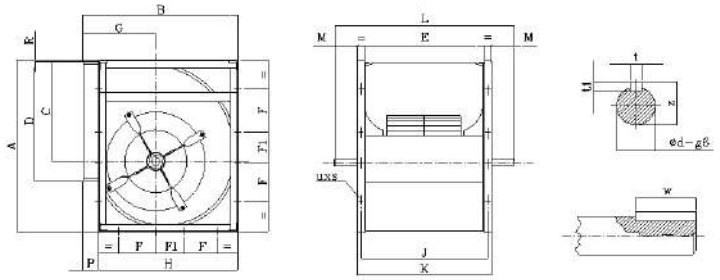
Fan Selection	
Fan Type	FDA
Unit	FDA630/CM (I)
Fan Quantity	1
Operating Conditions	Ducted
Required Volume	11,400 cfm
Required Static Pressure	50 mmwg
Air Volume	11,400 cfm
Static Pressure	50.0 mmwg
Velocity Pressure	4.34 mmwg
Total Pressure	54 mmwg
Outlet Velocity	8.41 m/s
Fan Total Efficiency	62.8 %
Fan Static Efficiency	57.7 %
Fan Speed	572 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	4.57 kW
Motor Selection	
Recommended Motor	D132 6p (5.50 kW)
Motor Speed	960 rpm
Service Factor	0 %
Operating Limits	
Max. Absorbed Power	15.00 kW
Max. Fan Speed	900 rpm
Temperature (Min-Max)	-20° to 85°C



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	85	85	83	83	76	72	68	62	90 dB
Lwo(Lin)	89	89	87	86	79	75	71	65	94 dB
Lwi(A)	59	68	74	80	76	73	69	60	83 dB(A)
Lpi(A)	49	58	64	70	66	63	58	50	73 dB(A)

Sound Pressure Level "Lpi" 1.5m from the inlet side, Room Conditions

(CCW90)



0DL	A	B	C	D	E	F	F1	G	H
45	1157	998	679	800	800	328	110	434	945

J	K	L	M	P	R	t	t1	UxS	w
850	900	1092	96	53	6	14	9	13x18	70

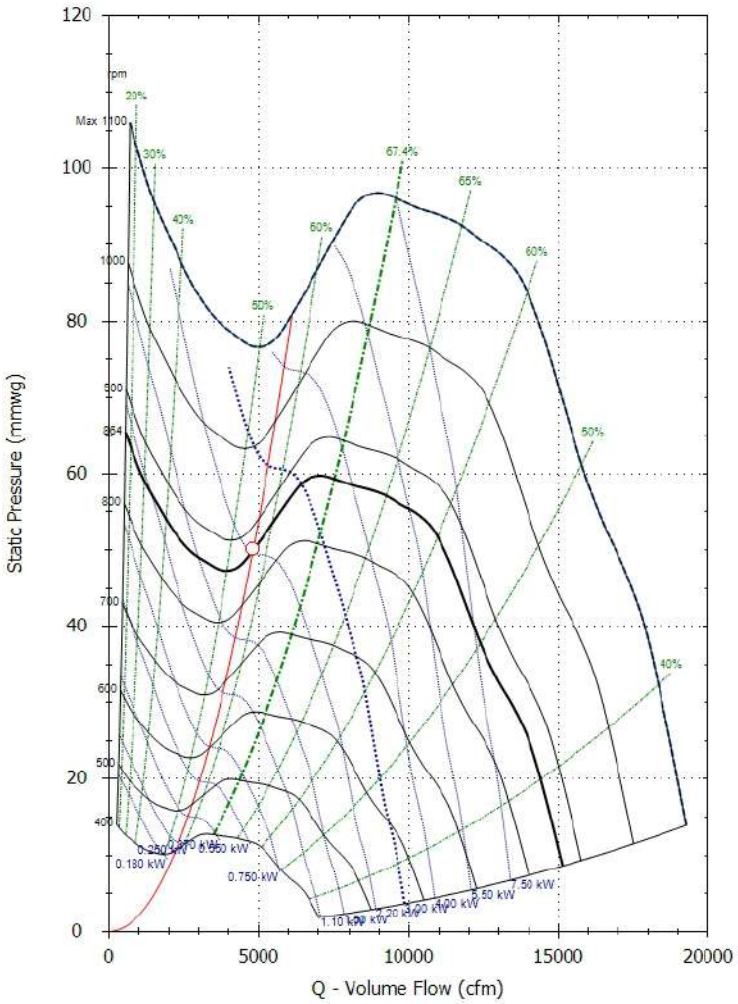
Weight	z
104	48.5

Date	09-12-2022
Company	
Attention	
Project	
Reference	KAT 18-18

Kruger Ventilation Industries Pte Ltd
No. 17 Tuas Avenue 10
Singapore 639141

Tel: +65 6861 1577 **Fax:** +65 6861 3577
Email: mktg@krugerasia.com

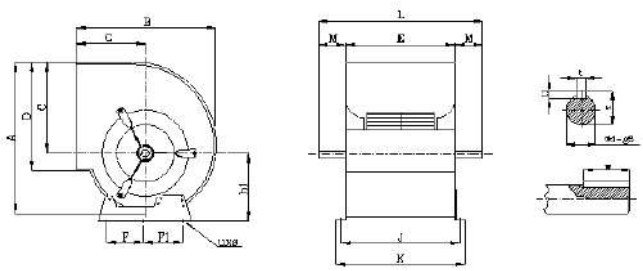
Fan Selection	
Fan Type	KAT
Unit	KAT 18-18/SL (I)
Fan Quantity	1
Operating Conditions	Ducted
Required Volume	4,800 cfm
Required Static Pressure	50 mmwg
Air Volume	4,800 cfm
Static Pressure	50.0 mmwg
Velocity Pressure	4.45 mmwg
Total Pressure	54 mmwg
Outlet Velocity	8.51 m/s
Fan Total Efficiency	54.5 %
Fan Static Efficiency	50.1 %
Fan Speed	864 rpm
Air Temperature	20 °C
Altitude	0 m
Fan Absorbed Power	2.22 kW
Motor Selection	
Recommended Motor	D132 6p (3.00 kW)
Motor Speed	960 rpm
Service Factor	0 %
Operating Limits	
Max. Absorbed Power	7.50 kW
Max. Fan Speed	1100 rpm
Temperature (Min-Max)	-20° to 85°C



Hz	63	125	250	500	1k	2k	4k	8k	Overall
Lwi(Lin)	84	85	85	83	82	75	71	65	91 dB
Lwo(Lin)	88	89	89	86	85	78	74	68	95 dB
Lwi(A)	58	68	77	80	82	77	72	64	86 dB(A)
Lpi(A)	47	58	66	70	71	66	62	53	75 dB(A)

Sound Pressure Level "Lpi" 1.5m from the inlet side, Room Conditions

KAT 'S' (CCW90)



0DL	A	B	C	D	E	F	F1	G	h1
25	739	684	415	478	557	288	318	314	340

h2	h3	J	K	L	M	t1m	tm	UxS	w
457	376	582	607	694	68.5	8	7	11x16	40

z
28

ZECO AIRCON LTD.

2nd Floor DDA Shopping Complex
Near Sindhi School
110060 - New Rajinder Nagar - New Delhi
India

Customer	
To the k. a. of	
Description	
Date	19-12-2022

Model	382522 _ IGT 48T 6NR 1738A 2.1P 48NC	Direct Expansion

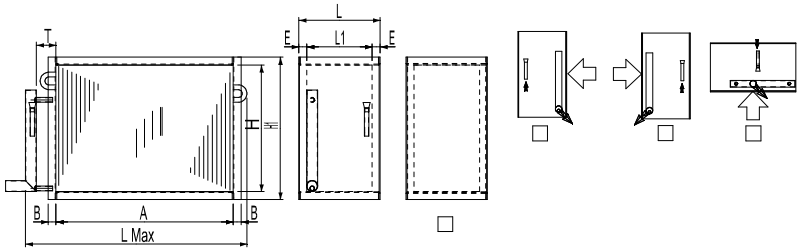
Total Capacity	ton(ref.)	28.615	Fins Material		Aluminium
Exchange Surface	m²	244.67	Tubes Material		Copper
Sensible/Total Capacity Ratio		0.766388177871704	Fin Thickness	mm	0.1500
Quantity of Produced Water	kg/h	34.0	Tube Thickness	mm	0.5000
Coil Internal Volume	l	31.8			

AIR SIDE

Atmospheric Pressure	bar A	1.01
Gas Inlet Temperature	m	0.00
Air Flow	cft/min	11400.0
Face Velocity on the Coil	m/s	2.54
Inlet Air Temperature	°C	23.0
Inlet Air Relative Humidity	%	52.0
Outlet Air Temperature	°C	11.2
Outlet Air Relative Humidity	%	92.1
Pressure Drop	Pa	119

REFRIGERANT SIDE

Fluid		R410A
Fluid Flow	kg/h	2201.0
Fluid Velocity (Gaseous Phase)	m/s	5.24
Fluid Velocity (Liquid Phase)	m/s	0.18
Subcooling Degrees	°C	15.0
Overheating Degrees	°C	5.0
Evaporating Temperature	°C	7.0
Condensing Temperature	°C	54.0
Pressure Drop in Degrees	K	0.5
Fluid Pressure Drop	psi	2.29
Manifold Pressure Drop	psi	0.00
Total Pressure Drop Fluid Side	psi	2.29



A	1738	mm
L	0	mm
H	1219	mm
B	0	mm
H1	0	mm
L1	132	mm

ZECO AIRCON LTD.

2nd Floor DDA Shopping Complex
Near Sindhi School
110060 - New Rajinder Nagar - New Delhi
India

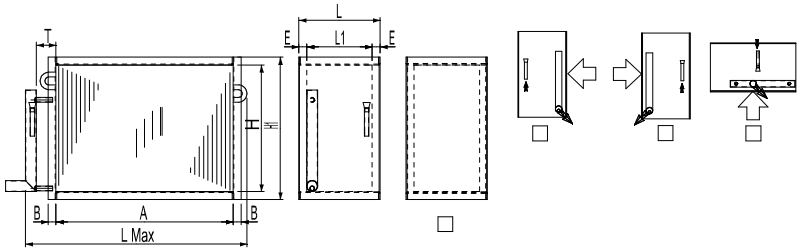
ZECO AIRCON LTD.

2nd Floor DDA Shopping Complex
Near Sindhi School
110060 - New Rajinder Nagar - New Delhi
India

Customer	
To the k. a. of	
Description	
Date	19-12-2022

Model	382522 _ IGT 32T 6NR 1098A 2.1P 32NC			Direct Expansion		
Total Capacity	12 TR	ton(ref.)	11.238	Fins Material		Aluminium
Exchange Surface		m²	103.05	Tubes Material		Copper
Sensible/Total Capacity Ratio		0.785919785499573		Fin Thickness	mm	0.1500
Quantity of Produced Water		kg/h	12.3	Tube Thickness	mm	0.5000
Coil Internal Volume		l	13.4			

AIR SIDE			**REFRIGERANT SIDE**		
Atmospheric Pressure	bar A	1.01	Fluid		R410A
Gas Inlet Temperature	m	0.00	Fluid Flow	kg/h	864.1
Air Flow	cft/min	4800.0	Fluid Velocity (Gaseous Phase)	m/s	3.09
Face Velocity on the Coil	m/s	2.54	Fluid Velocity (Liquid Phase)	m/s	0.10
Inlet Air Temperature	°C	23.0	Subcooling Degrees	°C	15.0
Inlet Air Relative Humidity	%	52.0	Overheating Degrees	°C	5.0
Outlet Air Temperature	°C	11.7	Evaporating Temperature	°C	7.0
Outlet Air Relative Humidity	%	91.5	Condensing Temperature	°C	54.0
Pressure Drop	Pa	116	Pressure Drop in Degrees	K	0.1
			Fluid Pressure Drop	psi	0.64
			Manifold Pressure Drop	psi	0.00
			Total Pressure Drop Fluid Side	psi	0.64

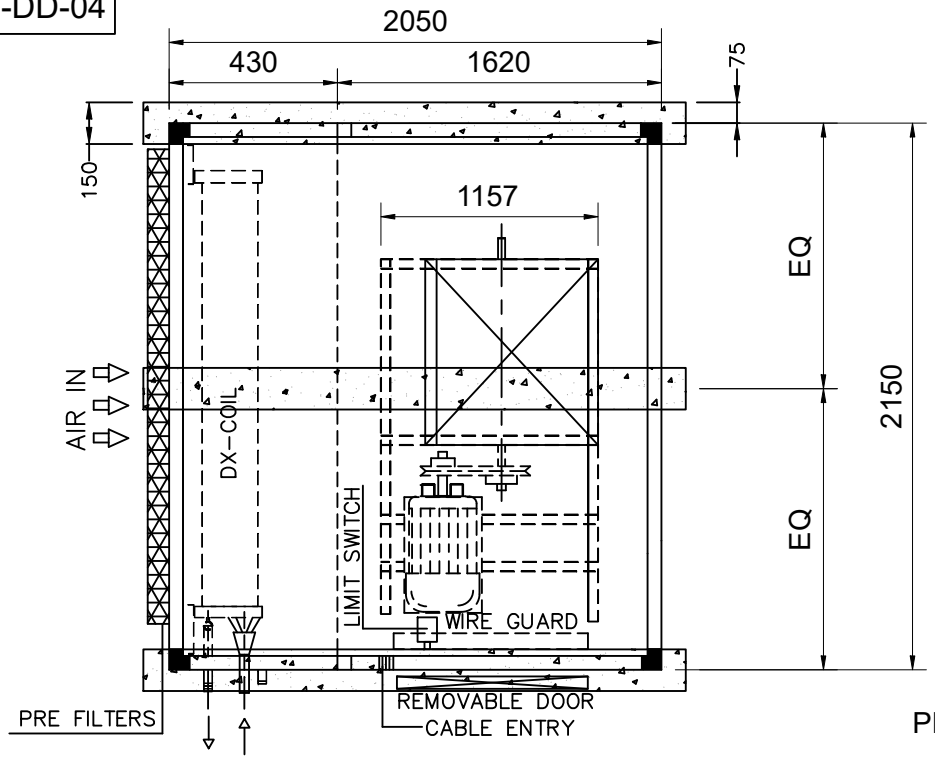


A	1098	mm
L	0	mm
H	812.8	mm
B	0	mm
H1	0	mm
L1	132	mm

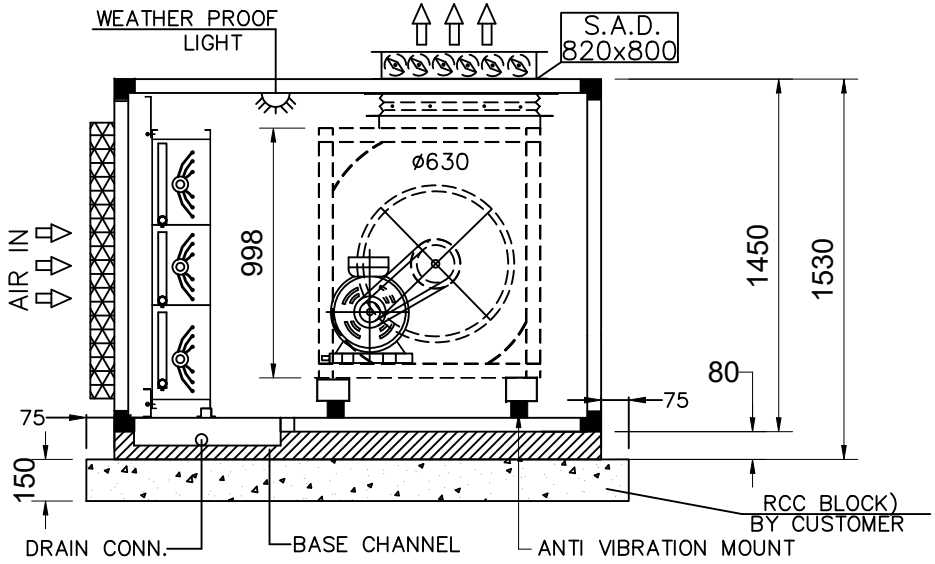
ZECO AIRCON LTD.

2nd Floor DDA Shopping Complex
Near Sindhi School
110060 - New Rajinder Nagar - New Delhi
India

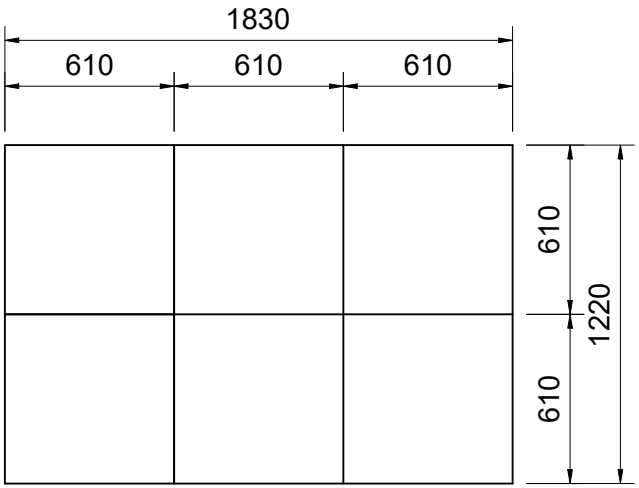
F-DD-04



PLAN



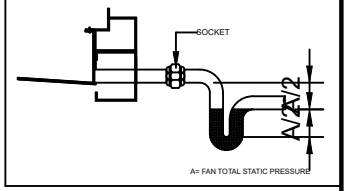
SECTION



SECTION

FILTER GRID DETAIL

CONDENSATE DRAIN TRAP(BY CUSTOMER)



STATIC WEIGHT - 915 KG.(APPROX.)
OPERATING WEIGHT - 1373 KG.(APPROX.)

UNIT QTY. -01 NO.

ALL DIMENSIONS ARE IN MM UNLESS, OTHERWISE SPECIFIED.
MAX. TOLERANCES ON OVERALL DIMENSIONS - ± 3 MM.

REV.	DESCRIPTION	DATED	REV. BY
A.	COIL RD CHANGED FROM 4 RD TO 6 RD	3.11.2022	KAPIL
B	S.P. INCREASE.	14-11-22	RAHUL
C	FAN WILL TOP DISCHARGE.	19-11-22	RAHUL

ZECO AIRCON LIMITED
O1 - O5 OLD INDUSTRIAL AREA, BAHADURGARH
PH # 01276-244650, 244651, 244652, 244653 FAX # 01276-244568
EMAIL # design@zecoaircon.com

CONSULTANT:-	DRN. BY	VIKAS
CLIENT:- M/S KONARK AIRCON	CHKD. BY	
	APPD. BY	
TITLE:- (11400 CFM)28.5 TR	DATE	22.10.2022
	SCALE	N.T.S.
DRAWING. NO. ZAL-221864-1C	PROJECT ROURKELA 1 PROJECT AT ODISHA	

KINDLY TICK THE FOLLOWING WHILE APPROVING THE DRAWING (FACING FROM FILTER SIDE)

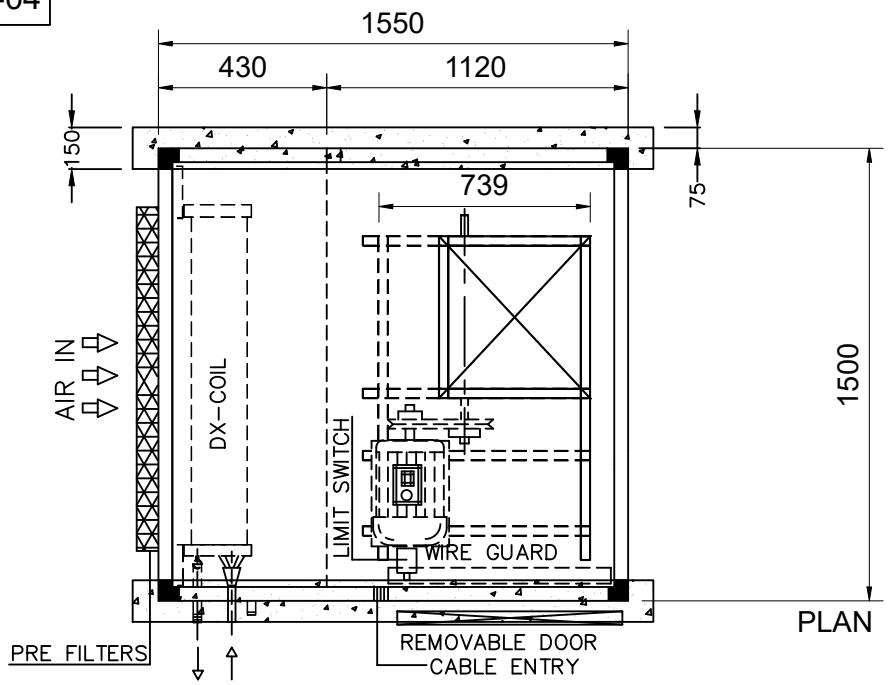
1) MOTOR LOCATION ☐ RHS ☐ LHS
2) COIL CONNECTION ☐ RHS ☐ LHS
3) FAN DISCHARGE

NOTE:- G.I. DAMPER WIDTH > 1000mm, AL. DAMPER WIDTH > 1200mm, WILL BE OPERATED FROM BOTH SIDES EXCEPT OUTLET DAMPER (IF DAMPER IN ZECO SCOPE).

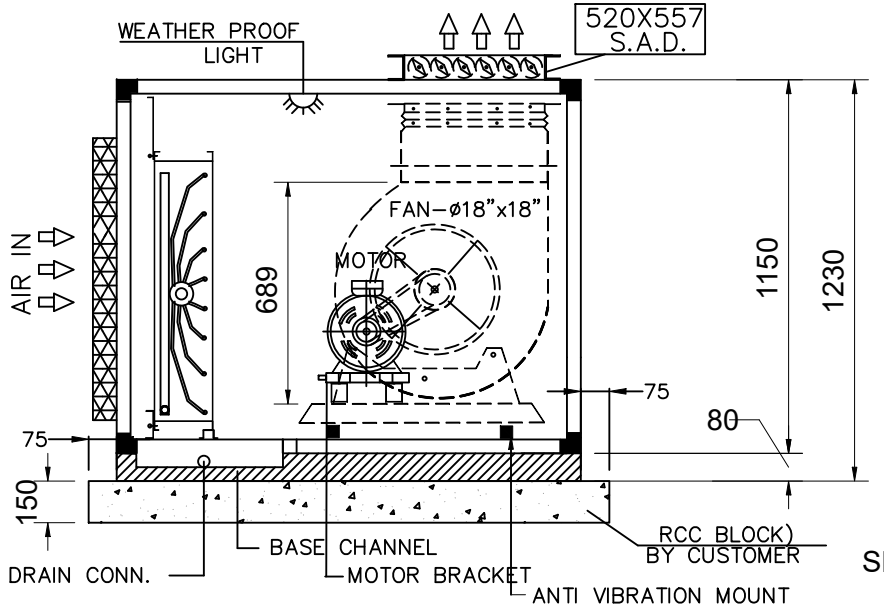
UNIT DISPATCH CONDITION

☐ ASSEMBLED
☐ SEMI KNOCK DOWN
☐ COMPLETE KNOCK DOWN

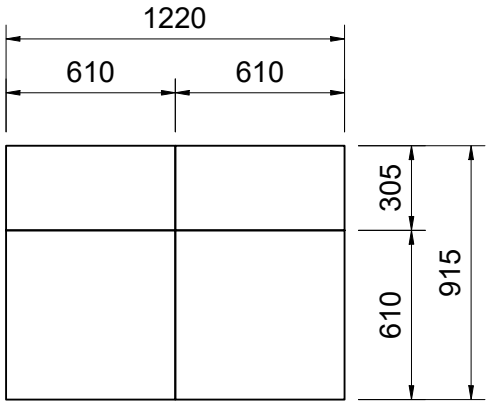
F-DD-04



PLAN

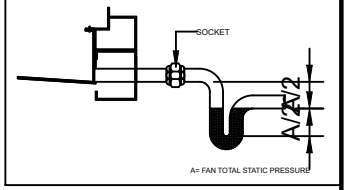


SECTION



SECTION
FILTER GRID DETAIL

CONDENSATE DRAIN TRAP(BY CUSTOMER)



STATIC WEIGHT - 475 KG.(APPROX.)
OPERATING WEIGHT - 713 KG.(APPROX.)

UNIT QTY. -02 Nos.

ALL DIMENSIONS ARE IN MM UNLESS, OTHERWISE SPECIFIED.
MAX. TOLERANCES ON OVERALL DIMENSIONS - ± 3 MM.

REV.	DESCRIPTION	DATED	REV. BY
A.	COIL RD CHANGED FROM 4 RD TO 6 RD	3.11.2022	KAPIL
B	S.P. INCREASE.	14-11-22	RAHUL
C	FAN WILL TOP DISCHARGE.	19-11-22	RAHUL

ZECO AIRCON LIMITED
O1 - O5 OLD INDUSTRIAL AREA, BAHADURGARH
PH # 01276-244650, 244651, 244652, 244653 FAX # 01276-244568
EMAIL # design@zecoaircon.com

CONSULTANT:-	DRN. BY	VIKAS
CLIENT:- M/S KONARK AIRCON	CHKD. BY	
	APPD. BY	
TITLE:- (4800 CFM) 12 TR	DATE	22.10.2022
	SCALE	N.T.S.
DRAWING. NO. ZAL-221864-2C	PROJECT ROURKELA 1 PROJECT AT ODISHA	

KINDLY TICK THE FOLLOWING WHILE APPROVING THE DRAWING (FACING FROM FILTER SIDE)

1) MOTOR LOCATION ☐ RHS ☐ LHS
2) COIL CONNECTION ☐ RHS ☐ LHS
3) FAN DISCHARGE

NOTE:- G.I. DAMPER WIDTH > 1000mm, AL. DAMPER WIDTH > 1200mm, WILL BE OPERATED FROM BOTH SIDES EXCEPT OUTLET DAMPER (IF DAMPER IN ZECO SCOPE).

UNIT DISPATCH CONDITION

☐ ASSEMBLED
☐ SEMI KNOCK DOWN
☐ COMPLETE KNOCK DOWN

CG Power and Industrial Solutions Limited

LT Motors Division
Ahmednagar

Apex IE2

DATA SHEET OF 3 PHASE INDUCTION MOTOR

Customer : Surya Power Engineers Enquiry / INDENT NO : DVD2211007/200 (Dated: 11/08/2022)

Frame	ND132S	Rated Output (kW)	5.5
Voltage (V)	415 +-10%	Rated Current (A)	10.15
Rated Speed (RPM)	1450	No of poles	4
Frequency (Hz)	50 +-5%	Duty	S1
Method of Cooling	IC411	Degree of Protection	IP55
Gas Group	Not applicable	Mounting	B3
Temp Class	NA		
Enclosure	TEFC Safe Area		
Load	100% Load	75% Load	50% Load
Efficiency	IE2 - 87.7 %	87.7 %	85.5 %
Power factor	0.86	0.80	0.70
AMB. Temp/Temp rise	50°C/70°C (By Resistance Method)		
Insulation class	F (Temp. rise limited to class 'B')		
Rated Torque (kg-m)	3.69		
Locked rotor current % FLC	650		
Starting torque % FLT	225		
Pull out torque % FLT	275		
Method of starting	Direct On Line		
Winding connections	Delta		
No of terminals	6		
Direction of rotation	Clockwise from DE		
Motor GD Sq. (kg-m²)	0.12		
Load GD Sq. (kg-m²)	0.12		
Starting time @100% V (Sec)	0.2		
Locked rotor Withstand time hot (Sec.)	8		
Locked rotor Withstand time cold (Sec.)	16		
Stator Thermal / Cooling time constant (min)	30 / 60		
Terminal box position	RHS From DE		
Cable size	1 * 3C,10-MM²		
Bearing DE/ODE	6308ZZ / 6208ZZ		
Type of lubrication	Sealed Bearing. No Lubrication Required		
Shaft Material	EN8 OR C40	Stator Body Material	Cast Iron
Net Weight (Approx.) kg	63		
Paint shade	RAL7034 Yellow grey		
Applicable standards	IS:1231,IS:12075,IS:12065,IS:325,		
Space heaters	N.A.		
Accessories	Not Applicable		

Please ensure & Submit the Details as follows:
1. QAP of motor to be submitted.
2. Following characteristic curves to be submitted:
a) Torque speed characteristic curve of the motor
b) Thermal withstand characteristic curve
c) Starting current vs time
d) Starting current vs speed
e) Power factor vs efficiency vs load
3. Safe stall time with 100% & 110% of rated
a) From hot condition
b) From cold condition

Customer specific requirement if any:

All performance data is subject to tolerance as per IS/IEC 60034

Issued By :		SURYA POWER ENGINEERS	
Date : 12/09/2022			

CG Power and Industrial Solutions Limited

LT Motors Division
Ahmednagar

Apex IE2

DATA SHEET OF 3 PHASE INDUCTION MOTOR

Customer : Surya Power Engineers Enquiry / INDENT NO : DVD2211008/1800 (Dated: 11/09/2022)

Frame	ND112M	Rated Output (kW)	3.7
Voltage (V)	415 +-10%	Rated Current (A)	7.10
Rated Speed (RPM)	1440	No of poles	4
Frequency (Hz)	50 +-5%	Duty	S1
Method of Cooling	IC411	Degree of Protection	IP55
Gas Group	Not applicable	Mounting	B3
Temp Class	NA		
Enclosure	TEFC Safe Area		
Load	100% Load	75% Load	50% Load
Efficiency	IE2 - 86.3 %	86 %	84 %
Power factor	0.84	0.80	0.70
AMB. Temp/Temp rise	50°C/70°C (By Resistance Method)		
Insulation class	F (Temp. rise limited to class 'B')		
Rated Torque (kg-m)	2.50		
Locked rotor current % FLC	600		
Starting torque % FLT	225		
Pull out torque % FLT	275		
Method of starting	Direct On Line		
Winding connections	Delta		
No of terminals	6		
Direction of rotation	Clockwise from DE		
Motor GD Sq. (kg-m²)	0.06		
Load GD Sq. (kg-m²)	0.06		
Starting time @100% V (Sec)	0.1		
Locked rotor Withstand time hot (Sec.)	8		
Locked rotor Withstand time cold (Sec.)	16		
Stator Thermal / Cooling time constant (min)	30 / 60		
Terminal box position	RHS From DE		
Cable size	1 * 3C,10-MM²		
Bearing DE/ODE	6306ZZ / 6205ZZ		
Type of lubrication	Sealed Bearing. No Lubrication Required		
Shaft Material	EN8 OR C40	Stator Body Material	Cast Iron
Net Weight (Approx.) kg	44		
Paint shade	RAL7034 Yellow grey		
Applicable standards	IEC 60034,IS:1231,IS:12075,IS:12065,		
Space heaters	N.A.		
Accessories	Not Applicable		

Please ensure & Submit the Details as follows:
1. QAP of motor to be submitted.
2. Following characteristic curves to be submitted:
a) Torque speed characteristic curve of the motor
b) Thermal withstand characteristic curve
c) Starting current vs time
d) Starting current vs speed
e) Power factor vs efficiency vs load
3. Safe stall time with 100% & 110% of rated
a) From hot condition
b) From cold condition

Customer specific requirement if any:

All performance data is subject to tolerance as per IS/IEC 60034

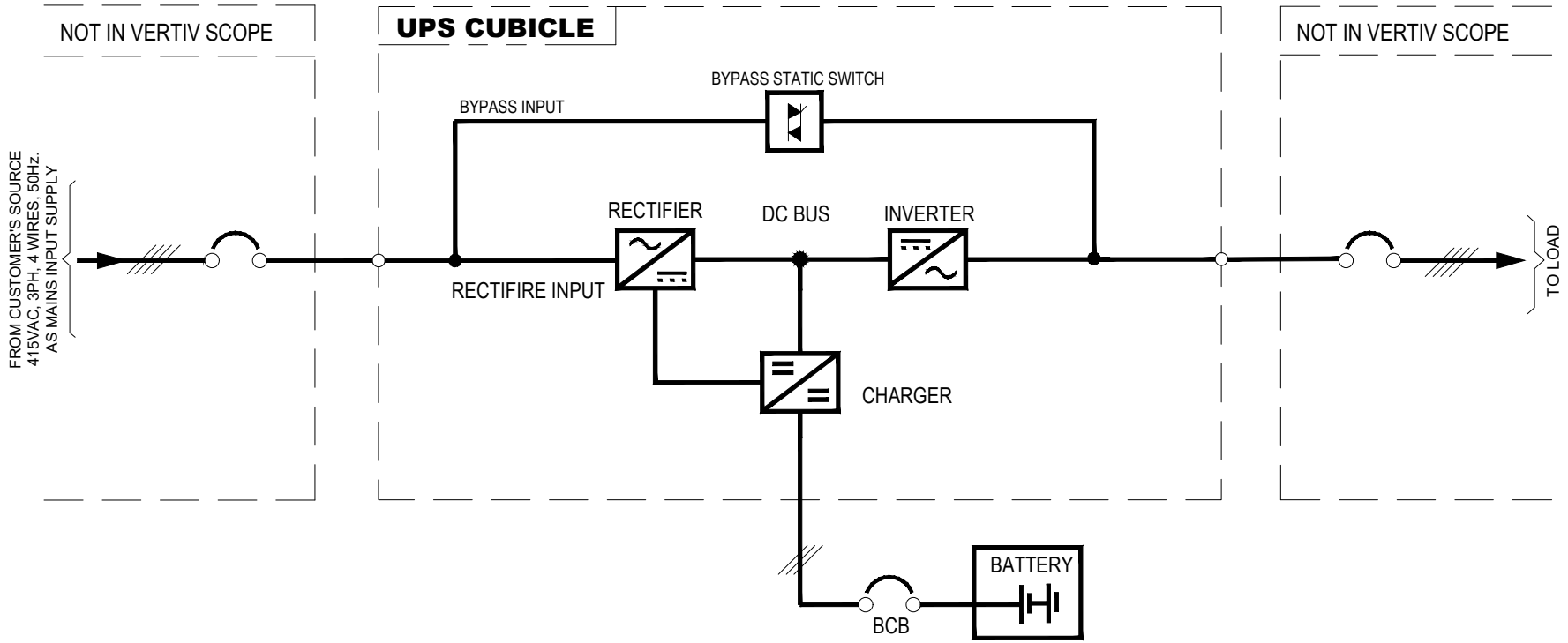
Issued By :		SURYA POWER ENGINEERS	
Date : 12/09/2022			

systemair

TECHNICALDATASHEET

VOLUMECONTROLDAMPER(MANUAL)

S.No.	DESCRIPTION	DETAILS
1	MAKE	SYSTEMAIRINDIA PVT.LTD.
2	SIZE	NECK-ASPERSITE REQUIRMENT
3	MODEL	GIVCD
4	MATERIALOFVCD	GALVANIZEDSHEET
5	THICKNESSOFMATERIAL	FRAME-16 SWGGISHEET
		LOUVER/BLADE-18 SWG GI SHEET
6	TYPE OFVCD	MANUAL
7	FINISH	ZINCCOATING (120GSM)
8	MOUNTING	DUCTCOLLAR
9	DEPTH	120MMSTANDARD
10	BUSH	BRONZBUSHWITHSELFLUBRICATION
11	WIDE	MINIMUMSIZE 300X300mm(NECK)
		MAXIMUMSIZE 1500 X 1000mm(NECK)
		SIZE ABOVE THAN MAXWILLBE INPARTITION



DATED :

PDF. NO.

REV.	DESCRIPTION	INITIALS

MATERIAL:

TRT.

ALL DIMENSIONS IN mm.

TOLERANCE :- NOT APPLICABLE

SCALE

TITLE : SINGLE LINE DIAGRAM FOR 30kVA ITA UPS

DRAWING NO.			REV.
PROP/SY/011			00
SHEET 1 OF 1			
APPD.	SEEMA		
CHKD.	SEEMA		
DRAWN.	AKSHAY	22/07/2022	

VERTIV TM.

VERTIV ENERGY PRIVATE LIMITED
(formerly Emerson Network Power (India) Private Limited)
Plot C-20, Road 19, Wagle Industrial Estate, Thane (W), Maharashtra, INDIA 400604

DRG. SIZE **A4**

VERTIV.

Liebert® APM™

18kW - 90kW
The Flexpower Technology for mission critical applications

Enabling Tomorrow's

CRITICAL EDGE INFRASTRUCTURE

We helped some of the largest names in the industry bring new capacity online faster and at a lower cost when search and social media increased demand for storage and computing.

Protecting your critical technologies takes more than just great software and equipment. It takes a level of experience that only comes from years of finding solutions when the industry needed them most. We were the first to protect mainframes with precision cooling systems.

And now as challenges and demands grow, we continue to find better ways to help you strengthen your most vital applications. Formerly the Network Power business of Vertiv, we've brought together the most trusted and experienced names in critical infrastructure.

We were the first to introduce an integrated enclosure system to distributed networks.

Complemented by a network of nearly 250 service centers worldwide. It's a combination of experience and resources that allow us to better adapt to what's needed, anticipate what's next and continue to find solutions in ways other companies simply can't.

Our portfolio spans power, thermal and infrastructure management products, software and solutions.

Liebert® APM™

18kW - 90kW

The Flexpower Technology for mission critical applications

MODULARITY

Redundant intelligence and modular capacity ensure reliable operation

Liebert® FlexPower™ core assemblies incorporate distributed intelligence and scalable power in a common module. This technology allows configuration of a completely redundant power and control system, sized to match the capacity of the protected equipment, when power requirements change, capacity is easily added - without increasing the system footprint.

Using Flexpower core assemblies, the Liebert® APM™ can scale from 18 to 90kW in 18kW increments within a single cabinet.

EFFICIENCY

Liebert® APM™ offer the best efficiency in its class, with upto 98% in ECO mode operation

It is even more efficient when sizes in accordance with present system need, instead of purchasing larger capacity systems to anticipate future requirements.

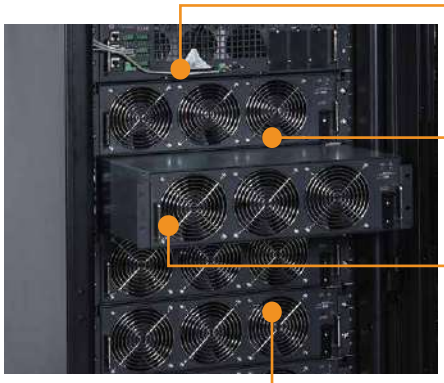
Lowest Total Cost of Ownership

- Buy only what you need for present usage, with the flexibility to add capacity as demand increases
- One-year warranty - provides full system coverage for one year
- Flexpower approach allows for sizing of the UPS, resulting in improved energy efficiency and reduced power expenditures

An Adaptable UPS that Meets increasing Power requirements

Prevent power interruptions and ensure the future flexibility and efficiency of your data center infrastructure, with the Liebert® APM™ UPS

- Modular Configuration
- Cost-efficient operation
- Flexibility to match increasing power demands
- Enterprise-level reliability



Standalone static bypass module- features independent controls in separate assembly to provide higher reliability

FlexPower core hardware assemblies enable quick and easy capacity increases without powering down the connected load

Distributed Controls - each FlexPower core assembly includes DSP controls, minimizing possibility of single point of failure

Expand for capacity or redundancy in 18kW increments within a single cabinet- 18kW to 90kW, no additional floor space is required

MODULARITY

With fewer basic building blocks you can build a power source tailored to your needs and ready to evolve with them.

HOT SWAP

Up and running in a few seconds thanks to the hot swappable modules.

ENERGY EFFICIENCY

Liebert® APM™ has been designed to deliver the best combination of energy efficiency and availability.

FLEXPOWER TECHNOLOGY

Liebert® APM™ features Flexpower Technology™, which incorporates distributed intelligence and scalable power in a common assembly.

Liebert® APM™

18kW - 90kW

The Flexpower Technology for mission critical applications

An Efficient Row-based UPS with the reliability features of an enterprise UPS System

Energy Efficient:
- Efficiency up to 98% in ECO mode Input Power Factor ~1; Input Harmonic current <3%

Easy to Install:
- Bottom cable inlet/outlet available. Integrates UPS and power distribution in a single cabinet

Easy to Maintain:
- Front access provides easy bypass maintenance and replacement of rectifiers, inverter and fans; Ultra quiet operations with noise level below 63dB;

Easy to Configure:
- Battery adopts 12V x 36/38/40 cell design and features flexible configu ration. The original battery system can be modified and poor cells can be replaced without affecting UPS performance.

Flexibility

Liebert® APM™ supports dynamic environments and IT asset growth with options for communications and application

- Capacity can be expanded in 18kW increments using FlexPower™ assemblies
- Easy Installation - front service access, smaller footprint
- Top or bottom cable entry - enable installation on raised or non-raised floors

Reliability

The Liebert® APM™ ensures reliable operation through quality components, intelligent design, and the industry's largest local support network

Higher Availability

- Redundancy and distributed intelligent features minimize single points of failure
- Distributed controls-each FlexPower™ core assembly includes DSP controls, minimizing possibility of single point of failure
- Standalone static bypass module-features independent controls in separate assembly to provide higher reliability

Scalable Power and Distribution*

- APM™ offers more than power scalability for availability as it also addresses power distribution among the equipment in the data center in a scalable manner
- As an Adaptive Power Manager, it provides long term solution for power distribution for vertical scalability. Expand your infrastructure whether by adding a UPS module or adding more servers and racks
- It allows the user to easily add modules using a plug and play structure while distributing work load through its intelligent control system.

Liebert® APM™

18kW - 90kW

The Flexpower Technology for mission critical applications

Integrated Power and Distribution Management in a Modular Rack

Unique in its class, the Liebert® APM™ provides complete, high efficient power protection and distribution in a single cabinet, eliminating the complexity of two stage power distribution.

1 Intelligent Server Power Manager
MCM/BCM control module able to detect status, voltage, current, power factor, harmonic level and energy consumption of each branch, and set 2-level current load pre warning.

2 Modular Power Distribution Module
Swappable distribution module (Optional) with 18-way circuit breaker for expansion and output distribution circuit adjustment

3 Hot Swappable circuit Breaker
Branch switch expansion or load adjustment can be done without turning off the main circuit UPS power supply. Load distribution uses dynamic configuration, with the UPS capacity and number of load distribution circuits changed with the increase in IT systems

4 Built-in distribution switch and manual maintenance bypass
Enable the UPS to transfer the load to utility in event of fault or overload, without interruption

5 Standalone static bypass module
Built-in swappable 90kW bypass module in separate assembly, UPS still support load upon failure of this module to ensure higher reliability

6 Hot swappable module
Each Power core assembly consist of its own DSP controller, minimizes possibility of single point of failure

7 Unity Power Factor*; 18 kW module
Offers more real power to support customer's mission critical load satisfying the requirements of the latest servers

Simple and Comprehensive Monitoring

Liebert® APM™ features an intuitive HMI that leads the user through logical menu sequences to view the required information. The microprocessor based display is autonomous of the system control logic. The simple menu-driven system virtually eliminates the possibility for diagram or mimic panel. It can also display advanced metering information, alarms, configuration or start-up/shut-down/transfer information.

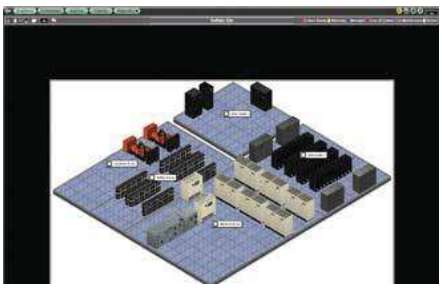
- Quickly check operational status
- Monitor power for through UPS along with all meter readings
- Menu-driven operator procedures to ensure safe operation
- Check status reports and history files
- Adjustment of programmable parameters (access limited by security access function)

Centralized Monitoring And Control For the IT Environment

Intended for the IT Manager, Liebert® Nform™ is a network communications system that enables you to leverage the distributed monitoring capabilities of your network connected equipment. This software solution combines full-scale monitoring with cost-effective deployment through the use of the existing network infrastructure. It is both scalable and adaptable so it can grow as your systems expand and business needs change. Liebert® Nform™ can be configured to monitor your Liebert® APM™ for alarm notifications. These alarms can be processed to trigger event actions such as email alerts or local notifications.

Centralized Monitoring And Control Through Your Existing Network

Liebert® Sitescan™ is centralized site monitoring system assuring maximum visibility and availability of your critical operations. Liebert® Sitescan™ Web allows you leverage Web technology to oversee and control critical support systems-any where, anytime. Liebert® Sitescan™ Web allows you to monitor and control virtually any piece of critical support equipment- whether it is located in the next room or in a facility on the other side of the country. The web-based system provides centralized oversight of any Liebert® precision air, power and UPS units, as well as many other analog or digital devices. Features include real-time monitoring and control, data analysis and trend reporting, and event manage-ment.



Note: Please consult your Vertiv sales representative for more details on software compatibility

Liebert® APM™

18kW - 90kW

The Flexpower Technology for mission critical applications

Specifications

Rated Power (In kVA/kW)*	18	36	54	72	90
Input					
Rated input voltage	380/400/415Vac, 3-phase and 4 -wire				
Input voltage range	305~477V ; 304-228 V for (o/p derated below 80%)				
Rated operating frequency	50/60Hz				
Input frequency range	40-70Hz				
Input power factor	=0.99 at full load, >0.98 at half load				
THDi*	Linear full load<3% (battery float charge); Non-liner full load <5% (battery float charge)				
Input power walk-in duration	20s				
Battery					
Float voltage	selectable from 2.2V/cell to 2.3V/cell				
Temperature compensation	-3.0mV/ °C/cl				
Ripple voltage	<=1.141%				
Boost voltage	selectable from 2.3 to 2.35V/cells				
EOD voltage	selectable from 1.60 to 1.85/cells				
Output					
Inverter output voltage	380/400/415Vac, 3-phase and 4-wire				
Nominal output frequency	50/60 (settable)				
Inverter overload capacity	1 hour for 110%; 10 mins for 125%; 1 min for 150%; 200ms for >150%				
Voltage Stability	±1% (balanced)				
Total harmonic voltage distortion	2% (linear load); 4% (non-linear load)				
Slew rate	0.6Hz/sec				
Bypass					
Bypass input voltage	380/400/415Vac, 3-phase and 4-wire				
Bypass overload capacity	<110% for continues; <150% for 1 min; 1000% for 100ms				
Bypass voltage tolerance	Upper limit: +10%, +15% or +20%; Lower limit: -10%, -15%, -20%, -30% or -40%				
Bypass frequency tolerance	±10% or ±20%, default: ±20%				
Synchronisation window	Rated frequency ±0.5, ±1, ±2, ±3 (optional)				
Dimensions and weight					
Dimensions (W x D x H) (mm)	600 x 1100 x 2000				
Weight(kg)	228	256	284	321	340
General					
Online mode efficiency	Up to 94%				
ECO mode efficiency	Up to 98%				
Operating temperature*	0~40 °C				
Storage temperature	-25~70 °C (without battery)				
Max operation altitude	=1000, derate power by 1% per 100m between 1000m and 2000m				
Noise (1m)	55	57	59	61	63
IP Class	IP20				
Color	Black ZP7021				
Standard	Safety: EN50091-1; IEC62040-1/AS62040-1, EMC: EN50091-2/IEC62040-2/AS 62040-2(C3) specifying the performance and test: EN50091-3/IEC62040-3/AS 62040-3(VFI SS 111)				

*Note: Condition apply

*Liebert APM™ also available with 0.9PF model(20/40/60/80/100kVA) to meet higher kVA requirement

*Specifications are subject to change without any prior notification

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Vertiv Energy Private Limited | Plot C-20, Rd No.19, Wagle Ind Estate, Thane (W), 400604. India

Honeywell | Addressable Monitor Modules

APPROVED

HM-DMMI-UL, HM-MM3E-UL, HM-DCZRM-UL

UL LISTED

General

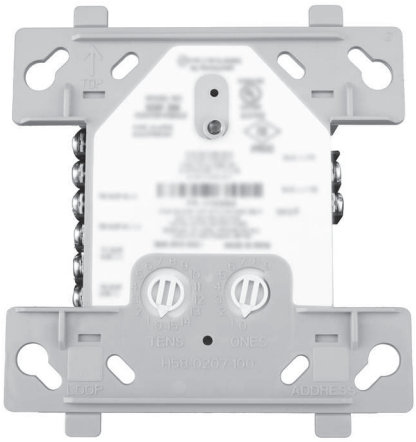
Three different monitor modules are available for fire alarm control panels – suiting a variety of applications. Monitor modules supervise a circuit of drycontact input devices, such as conventional heat detectors and pull stations, or to monitor and power two-wire smoke detector circuits.

HM-DMMI-UL is a standard-sized module (typically mounts to a 4”/10.16 cm square box) that supervises Class B circuit of dry contact input devices.

HM-MM3E-UL is a miniature monitor module – 1.3” (3.302 cm) H x 2.75” (6.985 cm) W x 0.65” (1.651 cm) D – that supervises Class B circuit of dry-contact input devices. Thanks to its compact design, the HM-MM3E-UL can be mounted in a single-gang box behind the device it monitors.

HM-DCZRM-UL is a standard-sized module used to monitor and supervise compatible two-wire, 24-Volt, smoke on a Class B circuit.

HM-DMMI-UL Monitor Module



HM-DMMI-UL

- Built-in type identification automatically identifies this device as a monitor module to the control panel
- Powered directly by two-wire SLC loop. No additional power required
- High noise (EMF/RFI) immunity
- SEMS screws with clamping plates for easy wiring
- Direct-dial entry of address: 61-99 for models SMX and STX
- LED flashes during normal operation and steadily illuminates to indicate alarm

The HM-DMMI-UL Monitor Module is intended for use in intelligent, two-wire systems, where the individual address of each module is selected using the built-in rotary switches. It provides either a two-wire or four-wire fault-tolerant Initiating Device Circuit (IDC) for normally open, contact fire alarm and supervisory devices. The module has a panel-controlled LED indicator.

HM-DMMI-UL Applications

Monitor a zone of four-wire smoke detectors, manual fire alarm pull stations, waterflow devices, or other normally open, drycontact alarm activation devices. Use it to monitor normally-open supervisory devices with special supervisory indication at the control panel. The monitored circuit may be wired as an NFPA (Class B) Initiating Device Circuit. A 47K Ohm end of line resistor (provided) terminates the Class B circuit.

HM-DMMI-UL Operation

Each HM-DMMI-UL uses one of the available module addresses on an SLC loop. It responds to regular polls from the control panel and reports its type and the status (open/normal/short) of its Initiating Device Circuit (IDC). A flashing LED indicates that the module communicates with the control panel. The LED steadily illuminates when an alarm starts (subject to current loop limitations).

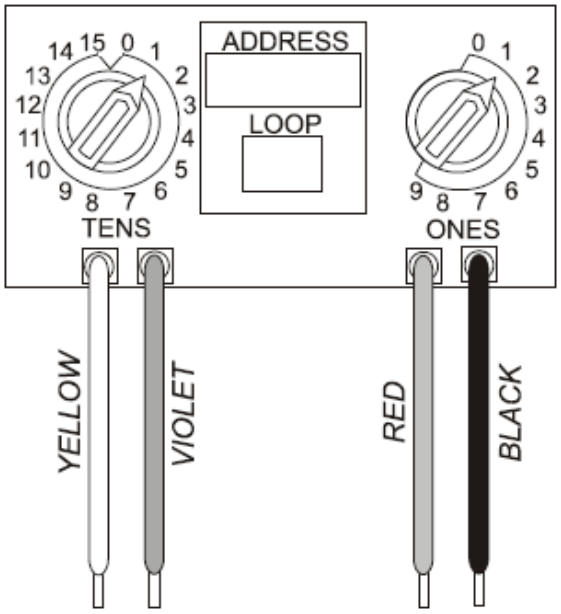
HM-DMMI-UL Specifications

Nominal operating voltage	15 to 32 VDC
Maximum current draw	5.0 mA (LED on)
Average operating current	375 µA (LED flashing), 1 communication every 5 seconds, 47k EOL
Maximum IDC wiring resistance	1500 Ohms
Maximum IDC Voltage	11 V
EOL resistance	47K Ohms
Temperature range	32°F to 120°F (0°C to 49°C)
Humidity range	10% to 93% non-condensing
Dimensions	4.5" (11.43 cm) high x 4" (10.16 cm) wide x 1.25" (3.175 cm) deep. Mounts to a 4" (10.16 cm) square x 2.125" (5.398 cm) deep box

HM-MM3E-UL Min-Monitor Module

HM-MM3E-UL

- Powered directly by two-wire SLC loop
  No additional power required
- High noise (EMF/RFI) immunity
- Tinned, stripped leads for easy wiring
- Direct-dial entry of address:
  61-99 for models SMX and STX



The HM-MM3E-UL Min-Monitor Module can be installed in a single-gang junction directly behind the monitored unit. Its small size and light weight allow it to be installed without rigid mounting. The HM-MM3E-UL is intended for use in intelligent, two-wire systems where the individual address of each module is selected using rotary switches. It provides a two-wire initiating device circuit for normally open, contact fire alarm devices.

HM-MM3E-UL Applications

Use to monitor a single device or a zone of four-wire smoke detectors, manual fire alarm pull stations, waterflow devices, or other normally open, dry contact devices. Monitor normally-open supervisory devices with special supervisory indication at the control panel. Monitored circuit/device is wired as an NFPA Class B Initiating Device Circuit. A 47K Ohm end of line resistor (provided) terminates the circuit.

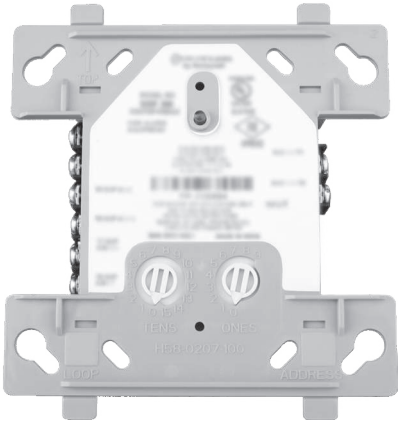
HM-MM3E-UL Operation

Each HM-MM3E-UL uses one of the available module addresses on an SLC loop. It responds to regular polls from the control panel and reports its type and the status (open/normal/short) of its Initiating Device Circuit (IDC).

HM-MM3E-UL Specifications

Nominal operating voltage	15 to 32 VDC
Average operating current	350 µA, 1 communication every 5 seconds, 47k EOL; 600 µA Max. (Communicating, IDC Shorted)
Maximum IDC wiring resistance	1500 Ohms
Maximum IDC Voltage	11 V
Maximum IDC Current	450 µA
EOL resistance	47K Ohms
Temperature range	32°F to 120°F (0°C to 49°C)
Humidity range	10% to 93% non-condensing
Dimensions	1.3" (3.302 cm) high x 2.75" (6.985 cm) wide x 0.65" (1.651 cm) deep
Wire length	6" (15.24 cm) minimum

HM-DCZRM-UL Interface Module



HM-DCZRM-UL

- Supports compatible two-wire smoke detectors
- Supervises IDC wiring and connection
  of external power source
- High noise (EMF/RFI) immunity
- SEMS screws with clamping plates for ease of wiring
- Direct-dial entry of address:
  61 -99 for models SMX and STX
- LED flashes during normal operation
- LED steadily illuminates to indicate an alarm
  on command from the control panel

The HM-DCZRM-UL Interface Module is intended for use in intelligent, addressable systems, where the individual address of each module is selected using built-in rotary switches. This module allows intelligent panels to interface and monitor two-wire conventional smoke detectors. It transmits the status (normal, open, or alarm) of one full zone of conventional detectors back to the control panel. All two-wire detectors being monitored must be UL compatible with the module.

HM-DCZRM-Ul Applications

Use the HM-DCZRM-UL to monitor a zone of two-wire smoke detectors. The monitored circuit may be wired as an NFPA Class B Initiating Device Circuit. A 3.9 K Ohm end of the line resistor (provided) terminates the end of the Class B circuit (maximum IDC loop resistance is 25 Ohms).

HM-DCZRM-UL Operation

Each HM-DCZRM-UL uses one of the available module addresses on an SLC loop. It responds to regular polls from the control panel and reports its type and the status (open/normal/short) of its Initiating Device Circuit (IDC). A flashing LED indicates that the module is in communicates with the control panel. The LED steadily illuminates when an alarm is on (subject to current loop limitations).

HM-DCZRM-UL Specifications

Nominal operating voltage	15 to 32 VDC
Maximum current draw	5.1 mA (LED on)
Maximum IDC wiring resistance	25 Ohms
Average operating current	270 μA, 1 communication and 1 LED flash every 5 seconds, 3.9k eol
EOL resistance	3.9K Ohms
External supply voltage (between Terminals T10 and T11)	• DC voltage: 24 V power limited • Ripple voltage: 0.1 Vrms maximum • Current: 90 mA per module maximum
Temperature range	32°F to 120°F (0°C to 49°C)
Humidity range	10% to 93% non-condensing
Dimensions	4.5" (11.43 cm) high x 4" (10.16 cm) wide x 1.25" (3.175 cm) deep. Mounts to a 4" (10.16 cm) square x 2.125" (5.398 cm) deep box

Installation

HM-DMMI-UL, and HM-DCZRM-UL modules mount directly to a standard 4" (10.16 cm) square, 2.125" (5.398 cm) deep, electrical box. They may also be mounted to the SMB500 surface mount box. Mounting hardware and installation instructions are provided with each module. All wiring must conform to applicable local codes, ordinances, and regulations. These modules are intended for power-limited wiring only.

The HM-MM3E-UL module is intended to be wired and mounted without rigid connections, inside a standard electrical box. All wiring must conform to applicable local codes, ordinances, and regulations.

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL:** S35595

Product Line Information

HM-DMMI-UL	Addressable Monitor Module
HM-MM3E-UL	Addressable Min-Monitor Module
HM-DCZRM-UL	Addressable Interface Module

NOTE: See installation instructions CN-MN-0196, CN-MN-0197 and CN-MN-0198 and refer to the SLC Wiring Manual.

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HM-DMMI-UL, HM-MM3E-UL,
HM-DCZRM-UL | Rev 01 | 08/19

REACH & RoHS ✓

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RR KABEL LTD

RR KABEL

GURANTEED TECHNICAL PARTICULARS

CABLE TYPE:	**Copper STR Conductor, XLPE Insulated & FRLS Sheathed Wire ARM cable**		
CABLE SIZE :			**2C X 1.5 mm^2**
SR.NO.	**PARAMETER**	**UNIT**	**SPECIFICATION**
A	**General Particulars**		
1	Make & Country	_	RR KABEL , INDIA
2	Type		2XWY
3	Voltage Grade	V	1100 volts
4	Standard drum length with tolerance	mtr	1000 (± 5%)
5	Recommended minimum bending radius	mm	Cable diameter x 12
6	Approx. cable diameter ± 1 mm	mm	11
7	Max. Tensile strength		
	For Cable pulled with stocking (Newtons)		9 x D^2
B	**Design & Construction**		
1	**Conductor**		
	a) Material		Annealed Copper
	b) Type of Conductor		Class - 2, Stranded Round Conductor as per IS 8130
	c) Number of wire	Nos	7
	d) Maximum conductor temperature for cont. use	Deg C	90
	e) Maximum conductor resistance at 20 deg c	Ohm/Km	12.10
2	**Insulation Of Conductor**		
	a) Material		XLPE
	b) Type		As per IS:7098 (P-1) specification
	c) Thickness nominal	mm	0.6
	d) Color of core		RD, BK
	e)Volume Resistivity test		
	1) at 27 °C	Ohm-cm	1 x 10^{14} min
	2) at 90 °C	Ohm-cm	1 x 10^{12} min
	f) Before Aging test		
	1) Tensile Strength	N / mm^2	12.5 min
	2) Elongation at break	%	200 min
3	**Lay - up**		
	a) Lay Direction		Right hand direction
4	**Inner Sheath**		
	a) Material		PVC as per IS: 5831
	b) Thickness Min	mm	0.30
	c) Color of sheath		Black (Extruded)
5	**Armouring**		
	a) Armouring Material		G.I. Wire
	b) Dimension of Wire	mm	0.90 (± 0.025 mm Tolerance)
	c) Lay direction of Armouring		Left Hand Direction
6	**Outer Sheath**		
	a) Material		PVC ST-2 FRLS Compound as per IS 7098 P-1
	b) Thickness (Nominmal/minimum)	mm	1.38/1.24
	c) Color of sheath		**Red**
	d) Before Aging test		
	1) Tensile Strength	N / mm^2	12.5 min
	2) Elongation at break	%	150 min
	e) Flammability test		
	1) Length of undecomposed portion from top clamp	mm	50 min
	2) Period of burning	sec.	60
7	**Printing Message**		**RR KABEL 2C X 1.50 SQ.MM 1100 V 2XWY FRLS ELECTRIC CABLE REACH RoHS CE +0001m**
8	**FRLS TEST ON OUTER SHEATH**		
	Oxygen Index test as per ASTM D-2863 and IS:10810 Part-58	%	29 (min)
	Temperature Index Test as per ASTM D-2863 and IS:10810 Part-58	°C	250 (min)
	Halogen Acid gas evaluation test as per IEC-754(Part-I)	%	20 (max)
	Smoke density rating .	%	60 (max)
9	**Electrical Properties**		
	High Voltage Test		3kV for 5 minutes
	Current Carrying Capacity		
	In Ground @ 30°C	Amps.	33
	In Duct @ 30°C	Amps.	25
	In Air @ 40°C	Amps.	29
	Approx Capacitance	µF/KM	0.18
	Approx Reactance at 50 Hz	Ω/Km	0.107
	Short Circuit Rating for 1 Sec	K.Amps	0.21
	Maximum conductor resistance at 20° C (D.C)	Ω/Km	12.1
	Maximum conductor resistance at 90° C (A.C)	Ω/Km	15.4
	Permissible Voltage Variation	%	± 10
	Permissible Frequency Variation	%	± 5
	Combined Voltage & Frequency variation	%	± 10

Prepared By: Dhairya Parmar — Doc. No: RRKL W/ GTP/2018/0213

Date : 14/08/2018 — Revision: 01

APPROVED

OSI-R-SS Conventional Reflective Imaging Beam Smoke Detector

This conventional, single-ended beam smoke detector is easy to install – only one side needs to be wired.

Features

- Combined transmitter/receiver unit
- Wide 12° field of view
- Fast, easy, and intuitive beam alignment indicated by directional LED cross-hair arrows
- Long range coverage of 5-100 m (16-328 ft) is standard; no separate long-range kit required
- Highly resistant to building movement; tolerates +/- 1° movement
- Resistant to strong light sources; does not alarm when saturated by sunlight
- Resistant to solid object intrusion
- Automatic sensitivity threshold level setting
- 50° horizontal and 20° vertical beam adjustment
- Built-in imager heater is standard
- Remote test station capable for electronic simulated smoke test from ground level
- Standby, fault and alarm LED indicators visible from the front and bottom
- Automatic drift compensation
- Paintable housing/cover
- Removable plug-in terminal blocks
- Optional heater kit available for the reflector

Agency Listings

UL LISTED S911

FM APPROVED PR449231

7260-1653: 0514

OSI-R-SS is a 4-wire conventional reflector-type linear optical beam smoke detector for use in fire alarm systems. The beam operates primarily on the principle of light obscuration using an infrared beam. Optical beam smoke detectors are uniquely suited to protecting buildings with large open areas with high ceilings such as a warehouse or atrium. The OSI-R-SS detector is a combined transmitter/receiver unit that can be directly connected to a conventional detector circuit.

Fast and Easy Alignment

Aligning the imager to the reflector is extremely intuitive, fast, and accurate. Both the infrared transmitter and the CMOS imager are contained in a moveable “eyeball” – an adjustable lens assembly that can move +/- 20° in the vertical direction and 50° in the horizontal direction.

Four LED arrows indicate the direction to move the lens, guiding the user to find the imager’s perfect alignment with the reflector.

Once the optimum alignment is found, indicated by all green arrows, the lens is locked with a slide lever. A paintable cover is then placed over the front to secure the lever in locked position.

Resistant to Building Movement

The infrared transmitter and receiver imager generates a beam of light towards a high-efficiency reflector. The reflector returns the beam to the receiver where the received signal is analysed. The change in the strength of the received signal when smoke enters the area between the unit and the reflector is used to determine the alarm condition. The receiver imager has a wide 12° field of view that automatically tracks the reflector in case of building movement or movement of its support structure. It is virtually impossible for the receiver to lose sight of the reflector from its field of view without structural damage being caused to the building. As a result of this operation, OSI-R-SS is highly resistant to building movement, eliminating the number one cause of false alarms and/or faults with traditional beam detectors.

Resistant to Sunlight

Optical filtering, high-speed image acquisition and intelligent software algorithms provide the OSI-R-SS system with higher levels of stability and greater resistance to high level lighting variability. This provides better resistance to sunlight in its field of view, helping to prevent false alarms when saturated by sunlight, reflected sunlight or any other very bright light sources. The worst-case scenario is for the detector to go into a trouble condition unlike other traditional beam detectors which go into alarm.

Resistant to Foreign Object Intrusion

Advanced smoke imaging techniques allow the detector to avoid false alarms from partial and sudden blockage from foreign object intrusion.

Time-saving Automatic Sensitivity Setting

Unique in the market, the sensitivity of the detector is selected and set automatically at the optimum sensitivity based on the size of the reflector measured in the field of view.

Drift Compensation

The detector incorporates automatic drift compensation, whereby the detector will adjust its detection thresholds in line with any long-term signal reduction of the beam caused by dust or other contamination of the optical surfaces.

Equipped with Built-in Imager Heater

The imager ships standard with an internal heating option to prevent condensation on the optical surface. (External power supply required.)

Specifications

Physical/Operating Specifications	
Dimensions (Detector)	Height 6” (152.4 mm); Width 10” (254 mm); Depth 4.5” (114.3 mm)
Dimensions (Reflector)	Height 9.06” (230 mm); Width 7.87” (200 mm)
Weight (Installed)	2.48 lbs (1.12 kg)
Weight (Shipping):	3.91 lbs (1.77 kg)
Wire Gauge for Terminals	14 AWG (2.08 mm^2)

Electrical Specifications: OSI-R-SS, OSI-RA-SS	
Operating Voltage Range	10.2 to 32 VDC (12 or 24VDC nominal)
Maximum Standby Current	7 mA @ 32 VDC 11 mA @ 24 VDC 20 mA @ 12 VDC 50 mA @ 10.2 VDC
Maximum Alarm Current (LED on)	11 mA @ 32 VDC 15 mA @ 24 VDC 24 mA @ 12 VDC 54 mA @ 10.2 VDC

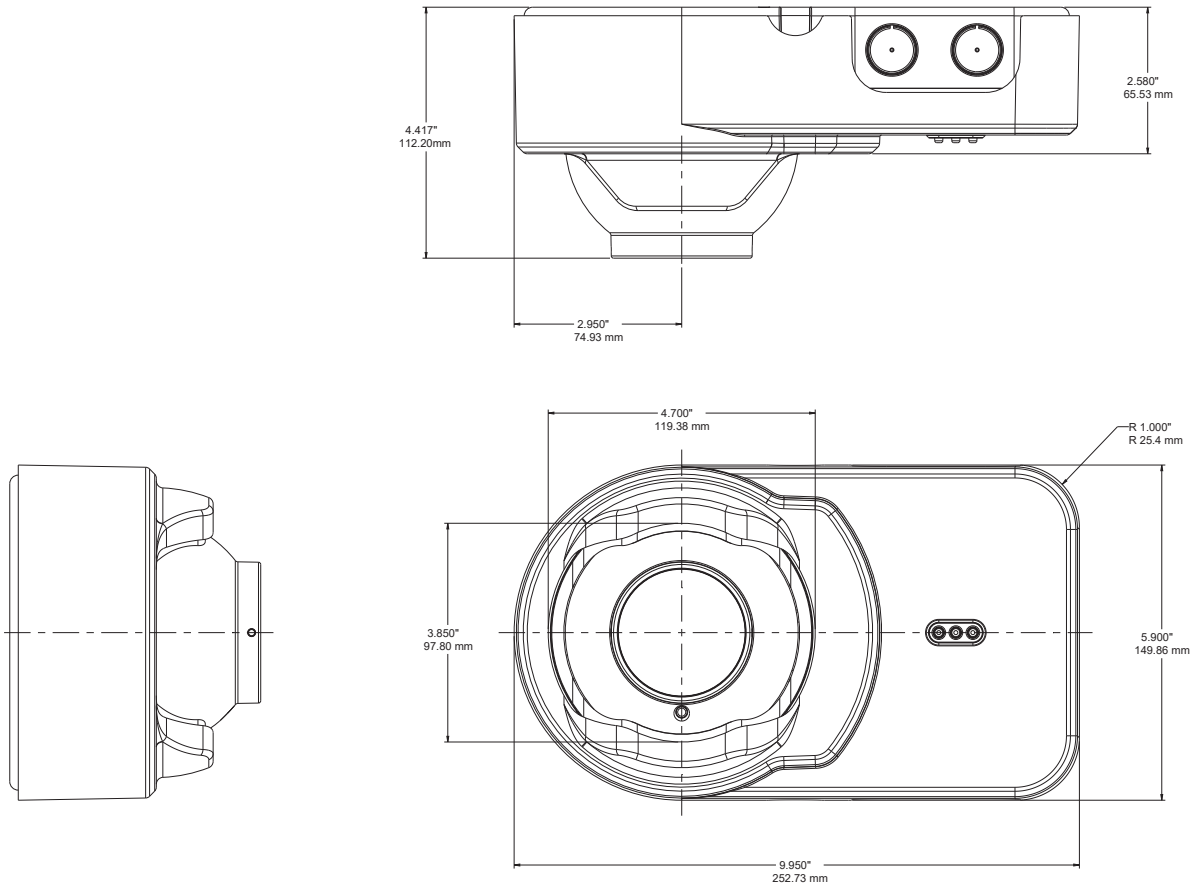
Environmental Specifications	
Operating Humidity Range	0 to 95% Relative Humidity, Non-condensing
Operating Temperature Range	UL-Listed for use from 32°F to 100°F (0°C to 37.8°C) Application Temperature Range: -20°C to +55°C (-4°F to 131°F)

Operational Specifications	
Protection Range	16 ft to 328 ft (5 m to 100 m)
Adjustment Angle	20 degrees vertical, 50 degrees horizontal
Sensitivity Levels	Level 1 25%, Level 2 30%, Level 3 40%, Level 4 50%
Fault Condition (Trouble)	Long-term drift reference out of 20% range, beam blockage or detector out of alignment, imager saturated.
Alignment Aid	LED directional arrows
Alarm Indicator	Local red LED and remote output
Trouble Indicator	Local yellow LED and remote trouble output
Normal Indicator	Local flashing green LED
Test/Reset Features	Local alarm test switch, local alarm reset switch, Remote test and reset switch (Compatible with RTS151 and RTS151KEY(-A) test stations), Uses OSID-R test filter.
Smoke Detector Spacing	On smooth ceilings, 30-60 feet between projected beams and not more than one-half that spacing between a projected beam and a sidewall. Other spacing may be used depending on the ceiling height, airflow characteristics, and response requirements. See NFPA 72 (S524 in Canadian applications).

Electrical Specifications: BEAMHKR	
Voltage Range	15 to 32 V
Maximum Current	450 mA Max at 32 V
Power Consumption	7.7 W @ 24 V 15 W @ 32 V

Electrical Specifications: RTS151KEY(-A)	
Voltage Range	10.2 to 32 VDC
Current Range	9 mA Min to 11 mA Max

Dimensions



C20151-00

Ordering Information

Part No.	Description
OSI-R-SS	Conventional imaging beam smoke detector including reflector, UL listed
OSP-002	Laser alignment tool
OSP-004	Test filter, 10-pack
RTS151	Remote test station
RTS151KEY	Test and reset station with key lock, flush mount, UL listed
BEAMHKR	Heater kit for the reflector

SYSTEM SENSOR®

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BMDS904-01 • 1/16/2019

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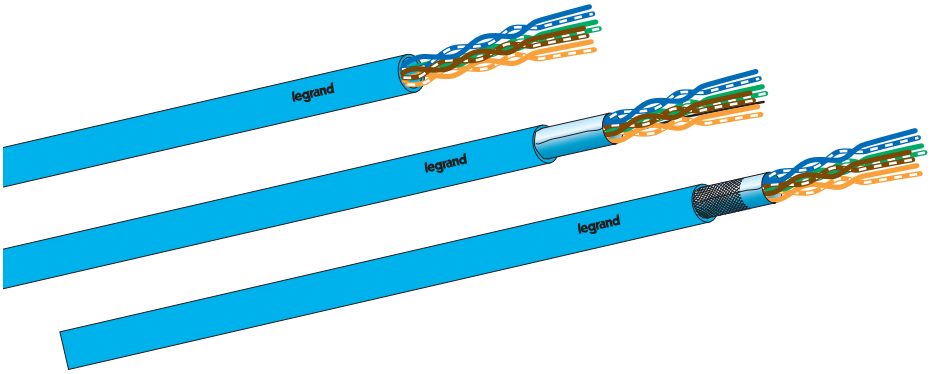
Category 6 PVC cables for LCS²

Catalogue number(s): **327 55/58/59/75**
328 57/72/75/76



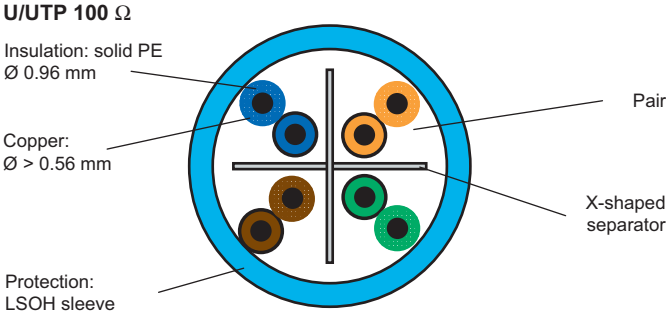
CONTENTS Pages

1. USE AND ASSEMBLY

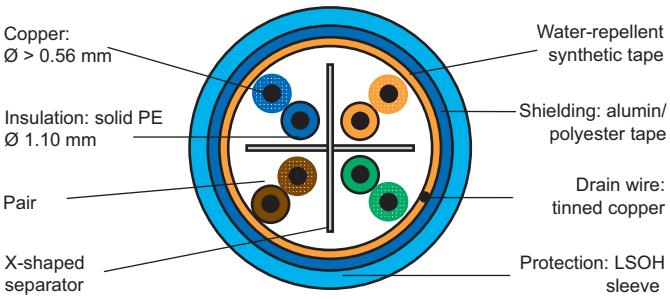
Cable for high-speed VDI transmission networks.

2. DESCRIPTION

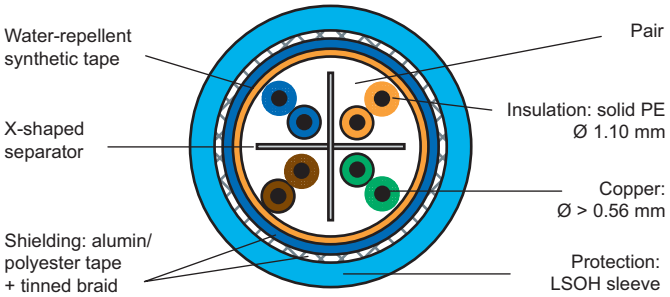
U/UTP 100 Ω



F/UTP 100 Ω



SF/UTP 100 Ω



Note:
The conductive part of the shielding is located on the wire side

3. MARKING OF LEGRAND CABLES

- Legrand
- Catalogue number
- Number of pairs
- Gauge
- Type
- Impedance
- Type of sleeve
- Category
- Conformity to standards
- VPN/NVP
- Batch number
- Measurement (remaining length)

4. PERFORMANCE AT 250 MHZ (standard ANSI/TIA 568-C.2)

Maximum attenuation (dB/100 m): 32.8
Minimum NEXT (dB): 38.3
PS NEXT (dB): 36.3
ACRF (dB/100 m): 18.8
PS ACRF (dB/100 m): 16.8
Return Loss (dB): 17.3

Category 6 PVC cables for LCS²

Catalogue number(s): **327 55/58/59/75**
328 57/72/75/76

5. TECHNICAL AND MECHANICAL FEATURES

Catalogue number	327 55	327 58	327 59	327 75	328 57	328 72	328 75	328 76
Type	U/UTP	F/UTP	SF/UTP	U/UTP	F/UTP	U/UTP	U/UTP	U/UTP
Type of sleeve	PVC	PVC	PVC	PVC	PVC	PVC	CMP	CMR
Number of pairs	4	4	4	2 x 4	4	4	4	4
Assembly	Pairs	Pairs	Pairs	Pairs	Pairs	Pairs	Pairs	Pairs
Diameter over insulation (mm)	1.02 ± 0.06	1.16 ± 0.05	1.16 ± 0.05	1.02 ± 0.06	1.16 ± 0.05	1.02 ± 0.06	1.02 ± 0.05	1.02 ± 0.05
Cable diameter (mm)	6.1 ± 0.3	7.1 ± 0.5	8.1 ± 0.3	6.2 ± 0.2 x 12.4 ± 0.6	7.1 ± 0.5	6.1 ± 0.3	6.1 ± 0.3	6.1 ± 0.3
Weight of cable (kg/km)	33 to 40	40 to 53	54 to 66	80 to 83	40 to 53	33 to 40	40	40
Min. bending radius when laying (mm)	25	60	65	25	60	25	25	25
AWG gauge	23	23	23	23	23	23	23	23

6. ELECTRICAL FEATURES AT 20°C

Catalogue number	327 55	327 58	327 59	327 75	328 57	328 72	328 75	328 76
Type	U/UTP	F/UTP	SF/UTP	U/UTP	F/UTP	U/UTP	U/UTP	U/UTP
Maximum linear resistance (ohm/km)	95 *	95 *	95 *	95 *	95 *	95 *	95 *	95 *
DC dielectric strength	1 KV/ 1 min *	1 KV/ 1 min *	1 KV/ 1 min *	1 KV/ 1 min *	1 KV/ 1 min *	1 KV/ 1 min *	1 KV/ 1 min *	1 KV/ 1 min *
Minimum insulation resistance (Mohm.km)	5000	5000	5000	5000	5000	5000	5000	5000
Minimum propagation speed	> 65%	> 65%	> 65%	> 65%	> 65%	> 65%	> 65%	> 65%
Characteristic impedance from 1 to 100 MHz	100 Ω ±15%	100 Ω ±15%	100 Ω ±15%	100 Ω ±15%	100 Ω ±15%	100 Ω ±15%	100 Ω ±15%	100 Ω ±15%

* According to standard IEC 61156-5

7. ORDERING INFORMATION

Catalogue number	327 55	327 58	327 59	327 75	328 57	328 72	328 75	328 76
Type	U/UTP	F/UTP	SF/UTP	U/UTP	F/UTP	U/UTP	U/UTP	U/UTP
Colour	Blue RAL 5015	Blue RAL 5015	Blue RAL 5015	Blue RAL 5015	Blue RAL 5015	Blue RAL 5015	Blue RAL 5015	Blue RAL 5015
Pack (m)	305	500	500	500	305	1000	305	305
Packaging	Box	Reel	Reel	Reel	Reel in box	Reel	Box	Box

8. ENVIRONMENTAL FEATURES

Storage and transport temperature: 0 to + 50°C
Usage temperature: – 20 to + 60°C
Fire resistance: IEC 60332-1, UL VW-1

9. STANDARDS AND APPROVALS

Cat. 6, 250 MHz
ANSI/TIA 568-C.2
EN 50173
EN 52288
IEC 11801
IEC 61156-5

The bridge to possible

Data Sheet

APPROVED

Cisco Catalyst 2960-L Series Switches

Contents

Product Overview

Cisco® Catalyst® 2960-L Series Switches are fixed and smart-managed Gigabit Ethernet switches that provide enterprise-class access switching for branch offices, out-of-the-wiring-closet applications, and critical Internet of Things (IoT) deployments, as well as small and medium-sized businesses. They operate on Cisco IOS® Software and support simple device management and network management via Command Line Interface (CLI) as well as an on-box web interface.

Catalyst 2960-L Smart Managed Switches are secure, reliable, enterprise grade switches built for small office deployments. These switches can be configured and managed via an on-box web interface allowing customers a quick and reliable way to get a small branch or office network up and running within minutes. These switches also feature limited CLI support for troubleshooting and monitoring.

The Cisco Catalyst 2960-L Series and 2960-L Smart Managed Switches are fully managed switches that offer advanced Layer 2 features as well as Power over Ethernet Plus (PoE+) power. These switches deliver enhanced network security, network reliability, and operational efficiency.

Product Highlights

Cisco Catalyst 2960-L Switches feature:

- 8, 16, 24, or 48 Gigabit Ethernet data or PoE+ ports with line-rate forwarding
- 2 or 4 fixed 1 Gigabit Ethernet Small Form-Factor Pluggable (SFP) uplinks or 4 fixed 10 Gigabit Ethernet SFP+ uplinks
- Perpetual PoE+ support with a power budget of up to 370W
- Enhanced version of Cisco IOS LAN Lite software
- CLI and/or intuitive Web-UI manageability options
- Device management support with:
  - Over-the-air access via Bluetooth, Simple Network Management Protocol (SNMP), RJ-45 or USB console access
  - Network management with Cisco Prime®, Cisco Network Plug and Play, and Cisco DNA Center
- Security with 802.1X support for connected devices, Switched Port Analyzer (SPAN), and Bridge Protocol Data Unit (BPDU) Guard
- Fanless operation with operating temperature up to 45°C
- Compact design with a depth of less than 11.5 inches
- Reliability with higher Mean Time Between Failures (MTBF) and an Enhanced Limited Lifetime Warranty (E-LLW)

Switch Models and Configurations

Cisco Catalyst 2960-L Switches include a single fixed power supply. Table 1 shows configuration information.

Table 1. Cisco Catalyst 2960-L Switches Configurations

Product ID*	10/100/1000 Ethernet ports	Uplink interfaces	Available PoE power	Fanless	Dimensions (H x D x W)	Weight
WS-C2960L-8TS-LL/ WS-C2960L-SM-8TS	8	2 SFP	–	Y	1.73 x 8.45 x 10.56 in. (4.4 x 21.5 x 26.8 cm)	3.33 lb (1.51kg)
WS-C2960L-8PS-LL/ WS-C2960L-SM-8PS	8	2 SFP	67W	Y	1.73 x 9.45 x 10.56 in. (4.4 x 24 x 26.8 cm)	4.50 lb (2.04kg)
WS-C2960L-16TS-LL/ WS-C2960L-SM-16TS	16	2 SFP	–	Y	1.73 x 8.45 x 10.56 in. (4.4 x 21.5 x 26.8 cm)	3.41 lb (1.55kg)
WS-C2960L-16PS-LL/ WS-C2960L-SM-16PS	16	2 SFP	120W	Y	1.73 x 9.45 x 10.56 in. (4.4 x 24 x 26.8 cm)	4.65 lb (2.11kg)
WS-C2960L-24TS-LL/ WS-C2960L-SM-24TS	24	4 SFP	–	Y	1.73 x 9.45 x 17.5 in. (4.4 x 24 x 44.5 cm)	6.04 lb (2.74kg)
WS-C2960L-24PS-LL/ WS-C2960L-SM-24PS	24	4 SFP	195W	Y	1.73 x 10.45 x 17.5 in. (4.4 x 26.5 x 44.5 cm)	7.41 lb (3.36kg)
WS-C2960L-48TS-LL/ WS-C2960L-SM-48TS	48	4 SFP	–	Y	1.73 x 9.45 x 17.5 in. (4.4 x 24 x 44.5 cm)	6.57 lb (2.98kg)
WS-C2960L-48PS-LL/ WS-C2960L-SM-48PS	48	4 SFP	370W	N	1.73 x 11.5 x 17.5 in. (4.4 x 29.2 x 44.5 cm)	10.08 lb (4.57kg)
WS-C2960L-24TQ-LL/ WS-C2960L-SM-24TQ	24	4 SFP+	–	Y	1.73 x 9.45 x 17.5 in (4.4 x 24 x 44.5 cm)	6.06 lb (2.75kg)
WS-C2960L-24PQ-LL/ WS-C2960L-SM-24PQ	24	4 SFP+	195W	Y	1.73 x 10.45 x 17.5 in (4.4 x 26.5 x 44.5 cm)	7.39 lb (3.35kg)
WS-C2960L-48TQ-LL/ WS-C2960L-SM-48TQ	48	4 SFP+	–	Y	1.73 x 9.45 x 17.5 in (4.4 x 24 x 44.5 cm)	6.68 lb (3.03kg)
WS-C2960L-48PQ-LL/ WS-C2960L-SM-48PQ	48	4 SFP+	370W	N	1.73 x 11.5 x 17.5 in (4.4 x 29.2 x 44.5 cm)	9.81 lb (4.54kg)

*Please refer to local price lists for full product SKUs.

Software

All Cisco Catalyst 2960-L Series Switches support an enhanced version of Cisco IOS LAN Lite software image. For more information about the software features supported on the Cisco Catalyst 2960-L Series, please refer to the Cisco Feature Navigator: https://tools.cisco.com/ITDIT/CFN/jsp/index.jsp.

Switch Management

Cisco Catalyst 2960-L Switches support the following on-device management features:

- **Web UI** via Cisco Configuration Professional. Configuration Professional provides a user interface for day-zero provisioning, which enables easy onboarding of the switch. Configuration Professional also has an intuitive dashboard for configuring, monitoring, and troubleshooting the switch (Figure 1). For more information, about Cisco Configuration Professional, please refer to https://www.cisco.com/c/en/us/products/cloud-systems-management/configuration-professional-catalyst/index.html.

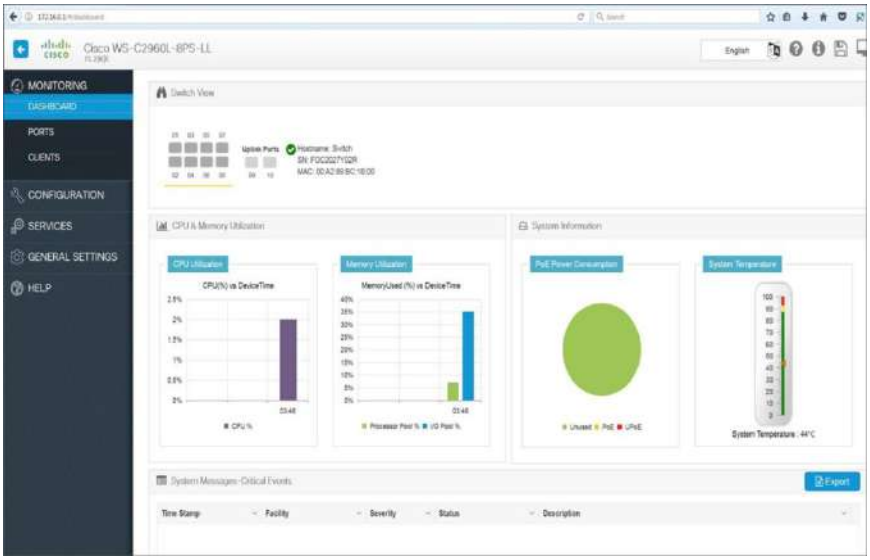


Figure 1.
Cisco Configuration Professional web UI for the Cisco Catalyst 2960-L Switches

- **Bluetooth** for over-the-air access. The switches support an external Bluetooth dongle that plugs into the USB port on the switch and allows a Bluetooth-based RF connection with external laptops and tablets (Figure 2). Laptops and tablets can access the switch CLI using a Telnet or Secure Shell (SSH) client over Bluetooth. The GUI can be accessed over Bluetooth with a browser.

Figure 2.
Over-the-air switch access using Bluetooth

Network Management

The Cisco Catalyst 2960-L Series Switches offer a superior CLI for detailed configuration and administration. The switches are also supported by the full range of Cisco network management solutions.

- **Cisco DNA Center** on the Cisco Catalyst 2960-L Series Switches provides a simple web user interface to enterprise network customers for day-zero plug and play, switch discovery and management, topology visualization, and software image management. For details on Cisco DNA Center features, please refer to dnac.cisco.com.
- **Cisco Prime Infrastructure** provides comprehensive network lifecycle management, including an extensive library of easy-to-use features to automate the initial and day-to-day management of your Cisco network. Cisco Prime technology integrates hardware and software platform expertise and operational experience into a powerful set of workflow-driven configuration, monitoring, troubleshooting, reporting, and administrative tools. For detailed information about Cisco Prime, visit cisco.com/go/prime.
- **Cisco Network Plug and Play** is supported using the Cisco Application Policy Infrastructure Enterprise Module (APIC-EM) and Cisco DNA Center on Cisco Catalyst 2960-L Series Switches. This provides a simple, secure, unified, and integrated offering for enterprise network customers to ease new branch or campus device rollouts or for provisioning updates to an existing network with a near zero-touch deployment experience. For detailed information about APIC-EM-based Plug-and-Play capabilities, please refer to Cisco Network Plug and Play. Licenses have to be purchased for using the Cisco Prime Infrastructure, Cisco Network Plug and Play, or Cisco DNA Center network management solution.

Intelligent PoE+

Cisco Catalyst 2960-L Switches support both IEEE 802.3af PoE and IEEE 802.3at PoE+ (up to 30W per port) to deliver a lower total cost of ownership for deployments that incorporate Cisco IP phones, Cisco Aironet® wireless access points, or other standards-compliant PoE and PoE+ end devices. PoE removes the need to supply wall power to PoE-enabled devices and eliminates the cost of adding electrical cabling and circuits that would otherwise be necessary in IP phone and WLAN deployments.

The Cisco Catalyst 2960-L Switches PoE power allocation is dynamic, and power mapping scales up to a maximum of 370W of PoE+ power. Intelligent power management allows flexible power allocation across all ports. With Perpetual PoE, the PoE+ power is maintained during a switch reload. This is important for critical endpoints such as medical devices and for IoT endpoints such as PoE-powered lights, so that there is no disruption during a switch reboot.

Network Security

Cisco Catalyst 2960-L Switches provide a range of security features to limit access to the network and mitigate threats, including:

- **Comprehensive 802.1X** features to control access to the network, including flexible authentication, 802.1X monitor mode, and RADIUS change of authorization.
- **802.1x support with Network Edge Access Topology (NEAT)** extends identity authentication to areas outside the wiring closet (such as conference rooms).
- **IEEE 802.1x User Distribution** enables you to load-balance users with the same group name across multiple different VLANs.
- **Disable per-VLAN MAC learning** manages the available MAC address table space by controlling which interface or VLANs learn MAC addresses.
- **Multidomain authentication** to allow an IP phone and a PC to authenticate on the same switch port while being placed on appropriate voice and data VLANs.
- **AAA command authorization** in plug-and-play (PnP) to enable seemless PnP provisioning.
- **Access control lists (ACLS)** for IPv6 and IPv4 security and Quality-of-Service (QoS) ACL elements (ACEs).
- **Port-based ACLs** for Layer 2 interfaces to allow security policies to be applied on individual switch ports.
- **SSH, Kerberos, and SNMPv3** to provide network security by encrypting administrator traffic during Telnet and SNMP sessions. SSH, Kerberos, and the cryptographic version of SNMPv3 require a special cryptographic software image because of U.S. export restrictions.
- **SPAN,** with bidirectional data support, to allow Cisco Intrusion Detection System (IDS) to take action when an intruder is detected.
- **TACACS+ and RADIUS authentication** to facilitate centralized control of the switch and restrict unauthorized users from altering the configuration.
- **MAC address notification** to notify administrators about users added to or removed from the network.
- **MAC authentication bypass and Webauth with downloadable ACLs** allows per-user ACLs to be downloaded from the Cisco Access Control Server (ACS) as policy enforcement after authentication using MAB or Web authentication in addition to IEEE 802.1X.
- **Web Authentication redirection** enables networks to redirect guest users to the URL that they had originally requested.
- **Multilevel security on console access** to prevent unauthorized users from altering the switch configuration.

- **BPDU guard** to shut down spanning-tree PortFast-enabled interfaces when BPDUs are received to avoid accidental topology loops.
- **IP Source Guard** restricts IP traffic on nonrouted, Layer 2 interfaces by filtering traffic based on the DHCP snooping binding database or manually configuring IP source bindings.
- **SSHv2** allows use of digital certificates for authentication between user and server.
- **Spanning-Tree Root Guard (STRG)** to prevent edge devices that are not in the network administrator's control from becoming Spanning Tree Protocol (STP) root nodes.
- **Internet Group Management Protocol (IGMP) filtering** to provide multicast authentication by filtering out nonsubscribers and to limit the number of concurrent multicast streams available per port.
- **Dynamic VLAN assignment** through implementation of VLAN Membership Policy Server client capability to provide flexibility in assigning ports to VLANs. Dynamic VLAN facilitates the fast assignment of IP addresses.

Redundancy and Resiliency

Cisco Catalyst 2960-L Switches offer a number of redundancy and resiliency features to prevent outages and help ensure that the network remains available:

- **IEEE 802.1s/w Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP)** provide rapid spanning-tree convergence independent of spanning-tree timers and also offer the benefits of Layer 2 load balancing and distributed processing.
- **Per-VLAN Rapid Spanning Tree (PVRST+)** allows rapid spanning-tree reconvergence on a per-VLAN spanning-tree basis, without requiring the implementation of spanning-tree instances.
- **Switch-port autorecovery (error disable)** automatically attempts to reactivate a link that is disabled because of a network error.
- **Link State Tracking** binds the link state of multiple interfaces. The server NIC adapters form a group to provide redundancy in the network. When the link is lost on the primary interface, network connectivity is transparently changed to the secondary interface.

Enhanced QoS

Cisco Catalyst 2960-L Switches offer intelligent traffic management that keeps everything flowing smoothly. Flexible mechanisms for marking, classifying, and scheduling deliver superior performance for data, voice, and video traffic, all at wire speed. Primary QoS features include:

- Up to **eight egress queues** and two thresholds per port, supporting egress bandwidth control, shaping, and priority queuing so that high-priority packets are serviced ahead of other traffic.
- **Ingress policing** allows the analysis of IP service levels for IP applications and services using active traffic monitoring - generating traffic in a continuous, reliable, and predictable manner—for measuring network performance. The number of ingress policers available per port is 64.
- **QoS through Differentiated Services Code Point** (DSCP) **mapping and filtering**.
- **QoS through Traffic Classification**
- **Trust Boundary** to configure device-based trust.
- **Auto-QoS** simplifies the deployment of QoS features.

- **Shaped Round Robin** (SRR) scheduling and **Weighted Tail Drop** (WTD) congestion avoidance.
- **802.1p Class of Service** (CoS) classification, with marking and reclassification.

  For more information on features supported on the intuitive Web-UI for Cisco Catalyst 2960-L Switches, refer to the Cisco Catalayst 2960-L Smart Managed Switches Configuration Guide.

Energy Management

Cisco Catalyst 2960-L Switches offer a range of industry-leading features for energy efficiency and management:

- **IEEE 802.3az Energy Efficient Ethernet** (EEE) enables ports to dynamically sense idle periods between traffic bursts and quickly switch the interfaces into a low-power idle mode, reducing power consumption.
- **Cisco EnergyWise**® policies can be used to control the power consumed by PoE-powered endpoints, desktop and data center IT equipment, and a wide range of building infrastructure. Cisco EnergyWise technology is included on all Cisco Catalyst 2960-L Series Switches. For more information about Cisco EnergyWise technology, visit cisco.com/go/energywise.
- **Cisco Catalyst SmartOperations** is a comprehensive set of capabilities that simplify LAN planning, deployment, monitoring, and troubleshooting. Deploying SmartOperations tools reduces the time and effort required to operate the network and lowers TCO.
- **Loop detection** is a new method to detect network loops in the absence of STP.
- **Cisco AutoConfig** services determine the level of network access provided to an endpoint based on the type of the endpoint device. This feature also permits hard binding between the end device and the interface.
- **Cisco Smart Install** services enable minimal-touch deployment by providing automated Cisco IOS Software image installation and configuration when new switches are connected to the network. This enables network administrators to remotely manage Cisco IOS Software image installs and upgrades.
- **Cisco Auto SmartPorts** services enable automatic configuration of switch ports as devices connect to the switch with settings optimized for the device type, resulting in zero-touch port-policy provisioning.
- **Cisco Smart Troubleshooting** is an extensive array of diagnostic commands and system health checks in the switch, including Smart Call Home. The Cisco Generic Online Diagnostics (GOLD) and online diagnostics on switches in live networks help predict and detect failures more quickly.

For more information about Cisco Catalyst SmartOperations, visit cisco.com/go/SmartOperations.

Operational Simplicity

- **Cisco AutoSecure** provides a single-line CLI to enable baseline security features (port security, Dynamic Host Configuration Protocol [DHCP] snooping, Dynamic Address Resolution Protocol [ARP] Inspection). This feature simplifies security configurations with a single touch.
- **DHCP** auto configuration of multiple switches through a boot server eases switch deployment.
- **Auto negotiation** on all ports automatically selects half- or full-duplex transmission mode to optimize bandwidth.

- **Dynamic Trunking Protocol (DTP)** facilitates dynamic trunk configuration across all switch ports.
- **Port Aggregation Protocol (PAgP)** automates the creation of Cisco Fast EtherChannel groups or Gigabit EtherChannel groups to link to another switch, router, or server.
- **Link Aggregation Control Protocol (LACP)** allows the creation of Ethernet channeling with devices that conform to IEEE 802.3ad. This feature is similar to Cisco EtherChannel technology and PAgP.
- **Automatic media-dependent interface crossover (MDIX)** automatically adjusts transmit and receive pairs if an incorrect cable type (crossover or straight-through) is installed.
- **Unidirectional Link Detection Protocol (UDLD)** and Aggressive UDLD allow unidirectional links caused by incorrect fiber-optic wiring or port faults to be detected and disabled on fiber-optic interfaces.
- **Local Proxy ARP** works in conjunction with Private VLAN Edge to minimize broadcasts and maximize available bandwidth.
- **VLAN1 minimization** allows VLAN1 to be disabled on any individual VLAN trunk.
- **IGMP** snooping for IPv4 and IPv6 and Multicast Listener Discovery (MLD) v1 and v2 snooping provide fast client joins and leaves of multicast streams and limit bandwidth-intensive video traffic to only the requesters.
- **Per-port broadcast, multicast, and unicast storm control** prevents faulty end stations from degrading overall system performance.
- **Voice VLAN** simplifies telephony installations by keeping voice traffic on a separate VLAN for easier administration and troubleshooting.
- **Cisco VLAN Trunking Protocol (VTP)** supports dynamic VLANs and dynamic trunk configuration across all switches.
- For enhanced traffic management, monitoring, and analysis, the embedded **Remote Monitoring (RMON)** software agent supports four RMON groups (history, statistics, alarms, and events).
- **Layer 2 trace route** eases troubleshooting by identifying the physical path that a packet takes from source to destination.
- **Trivial File Transfer Protocol (TFTP)** reduces the cost of administering software upgrades by downloading from a centralized location.
- **Network Time Protocol (NTP)** provides an accurate and consistent timestamp to all intranet switches.

Specifications

Product specifications (Table 2) apply to both PoE and non-PoE models.

Table 2. Specifications

*Routes, ACEs, and multicast group scale listed below are available starting with Cisco IOS Software Release 15.2(6)E. See the release notes for more information.

	8 port	16 port	24 port (1/10G uplinks)	48 port (1/10G uplinks)
Console ports				
RJ45 Ethernet	1	1	1	1
USB mini-B	1	1	1	1
USB-A port for storage and Bluetooth console	1	1	1	1
Memory and processor				
CPU	ARMv7 800 MHz	ARMv7 800 MHz	ARMv7 800 MHz	ARMv7 800 MHz
DRAM	512 MB	512 MB	512 MB	512 MB
Flash memory	256 MB	256 MB	256 MB	256 MB
Performance				
Forwarding bandwidth	10 Gbps	18 Gbps	1G: 28 Gbps 10G: 64 Gbps	1G: 52 Gbps 10G: 88Gpbs
Switching bandwidth	20 Gbps	36 Gbps	1G: 56 Gbps 10G: 128 Gbps	1G: 104 Gbps 10G: 176 Gbps
Unicast MAC addresses	16000	16000	16000	16000
IPv4 unicast direct routes	512	512	512	512
IPv4 unicast indirect routes	256	256	256	256
IPv6 unicast direct routes	414	414	414	414
IPv6 unicast indirect routes	128	128	128	128
IPv4 multicast routes and IGMP groups	1024	1024	1024	1024
IPv6 multicast groups	1024	1024	1024	1024
IPv4/MAC security ACEs	384	384	384	384
IPv6 security ACEs	256	256	256	256
Maximum active VLANs	256	256	256	256

	8 port	16 port	24 port (1/10G uplinks)	48 port (1/10G uplinks)
VLAN IDs available	4094	4094	4094	4094
Maximum STP instances	64	64	64	64
Maximum SPAN sessions	4	4	4	4
Jumbo Ethernet frame	10,240 bytes	10,240 bytes	10,240 bytes	10,240 bytes
MTBF in hours (data)	2,448,133	2,416,689	2,412,947	1,370,769
MTBF in hours (PoE)	315,044	313,496	909,838	437,970
Environment				
Operating temperature				
Up to 5,000 ft (1500 m)	23ºF to 113ºF (–5ºC to 45ºC)	23ºF to 113ºF (–5ºC to 45ºC)	23ºF to 113ºF (–5ºC to 45ºC)	23ºF to 113ºF (–5ºC to 45ºC)
	WS-C2960L-16PS-LL has maximum operating temperature of 40° C (up to 5,000 ft) and 35° C (up to 10,000 ft).			
Up to 10,000 ft (3000 m)	23ºF to 104ºF (–5ºC to 40ºC)	23ºF to 104ºF (–5ºC to 40ºC)	23ºF to 104ºF (–5ºC to 40ºC)	23ºF to 104ºF (–5ºC to 40ºC)
Operating altitude	10,000 ft (3000 m)	10,000 ft (3000 m)	10,000 ft (3000 m)	10,000 ft (3000 m)
Operating relative humidity	5% to 90% at 40ºC	5% to 90% at 40ºC	5% to 90% at 40ºC	5% to 90% at 40ºC
Storage temperature	–13º to 158ºF (–25º to 70ºC)	–13º to 158ºF (–25º to 70ºC)	–13º to 158ºF (–25º to 70ºC)	–13º to 158ºF (–25º to 70ºC)
Storage altitude	15,000 ft (4500 m)	15,000 ft (4500 m)	15,000 ft (4500 m)	15,000 ft (4500 m)
Storage relative humidity	5% to 95% at 65ºC	5% to 95% at 65ºC	5% to 95% at 65ºC	5% to 95% at 65ºC
Storage altitude	**Note:** Minimum ambient temperature for cold start is 0° C (32° F).			

Electrical	**Data**	**PoE**	**Data**	**PoE**	**Data**	**PoE**	**Data**	**PoE**
Voltage (auto ranging)	110 to 220V AC in	110 to 220V AC in	110 to 220V AC in	110 to 220V AC in	110 to 220V AC in	110 to 220V AC in	110 to 220V AC in	110 to 220V AC in
Frequency	50 to 60 Hz	50 to 60 Hz	50 to 60 Hz	50 to 60 Hz	50 to 60 Hz	50 to 60 Hz	50 to 60 Hz	50 to 60 Hz
Current	0.13A to 0.22A	0.22A to 0.27A	0.16A to 0.26A	0.24A to 0.28A	0.20A to 0.33A	0.21A to 0.26A	0.29A to 0.48A	0.37A to 0.64A
Power rating (maximum consumption)	0.04 kVA	0.11 kVA	0.05 kVA	0.19 kVA	0.06 kVA	0.24 kVA	0.09 kVA	0.48 kVA

	8 port		16 port		24 port (1/10G uplinks)		48 port (1/10G uplinks)	
Power consumption (watts)								
0% traffic	13.0	19.9	14.9	21.9	1G: 16.5	1G: 17.52	1G: 24.36	1G: 27.24
					10G: 17.04	10G: 16.68	10G: 25.8	10G: 27
10% traffic	14.8	22.0	19.3	27.1	1G: 23.04	1G: 24	1G: 33	1G: 39.24
					10G: 22.92	10G: 23.16	10G: 38.04	10G: 39.12
100% traffic	14.9	22.0	19.3	27.1	1G: 23.64	1G: 24	1G: 33.6	1G: 40.32
					10G: 23.64	10G: 23.76	10G: 39.36	10G: 40.56
Weighted average	14.2	21.3	17.8	25.4	1G: 21.06	1G: 21.84	1G: 30.32	1G: 35.6
					10G: 21.2	10G: 21.2	10G: 34.4	10G: 35.56
	Note: The wattage rating on the power supply does not represent actual power draw. It indicates the maximum power draw possible by the power supply. This rating can be used for facility capacity planning. For PoE switches, cooling requirements are smaller than total power draw because a significant portion of the load is dissipated in the endpoints.							
Acoustic noise (48-port PoE only)								
Sound pressure	LpA (typical)				35 dB			
	LpAD (maximum)				39 dB			
Sound power	LwA (typical)				4.8 B			
	LwAD (maximum)				5.2 B			
	Note: Bystander positions operating mode at 77°F (25°C) ambient.							
Safety and compliance								
Safety	UL 60950-1 Second Edition, CAN/CSA-C22.2 No. 60950-1 Second Edition, EN 60950-1 Second Edition, IEC 60950-1 Second Edition, AS/NZS 60950-1							
EMC: emissions	47CFR Part 15 (CFR 47) Class A, AS/NZS CISPR22 Class A, CISPR22 Class A, EN55022 Class A, ICES003 Class A, VCCI Class A, EN61000-3-2, EN61000-3-3, KN22 Class A, CNS13438 Class A							
EMC: immunity	EN55024 (including EN 61000-4-5), CISPR24, EN300386, KN24							
Environmental	Reduction of Hazardous Substances (RoHS) including Directive 2011/65/EU							
Telco	Common Language Equipment Identifier (CLEI) code							
U.S. government certifications	USGv6 and IPv6 Ready Logo							

	8 port	16 port	24 port (1/10G uplinks)	48 port (1/10G uplinks)
Connectors and interfaces				
Ethernet interfaces	10BASE-T ports: RJ-45 connectors, 2-pair Category 3, 4, or 5 Unshielded Twisted Pair (UTP) cabling			
	100BASE-TX ports: RJ-45 connectors, 2-pair Category 5 UTP cabling			
	1000BASE-T ports: RJ-45 connectors, 4-pair Category 5 UTP cabling			
	1000BASE-T SFP-based ports: RJ-45 connectors, 4-pair Category 5 UTP cabling			
Indicator LEDs	Per-port status: link integrity, disabled, activity, speed, and full duplex			
	System status: system, PoE, and link speed			
Console cables	CAB-CONSOLE-RJ45 Console cable 6 ft. with RJ-45			
	CAB-CONSOLE-USB Console cable 6 ft. with USB Type A and mini-B connectors			
Power	Use the supplied AC power cord to connect the AC power connector to an AC power outlet			
Management				
	BRIDGE-MIB CISCO-CABLE-DIAG-MIB CISCO-CDP-MIB CISCO-CLUSTER-MIB CISCO-CONFIG-COPY-MIB CISCO-CONFIG-MAN-MIB CISCO-DHCP-SNOOPING-MIB CISCO-ENTITY-VENDORTYPE-OID-MIB CISCO-ENVMON-MIB CISCO-ERR-DISABLE-MIB CISCO-FLASH-MIB CISCO-FTP-CLIENT-MIB CISCO-IGMP-FILTER-MIB CISCO-IMAGE-MIB CISCO-IP-STAT-MIB CISCO-LAG-MIB CISCO-MAC-NOTIFICATION-MIB CISCO-MEMORY-POOL-MIB CISCO-PAGP-MIB CISCO-POE-EXTENSIONS-MIB	CISCO-PORT-QOS-MIB CISCO-PORT-SECURITY-MIB CISCO-PORT-STORM-CONTROL-MIB CISCO-PRODUCTS-MIB CISCO-PROCESS-MIB CISCO-RTTMON-MIB CISCO-SMI-MIB CISCO-STP-EXTENSIONS-MIB CISCO-SYSLOG-MIB CISCO-TC-MIB CICSO-TCP-MIB CISCO-UDLDP-MIB CISCO-VLAN-IFTABLE CISCO-VLAN-MEMBERSHIP-MIB CISCO-VTP-MIB ENTITY-MIB ETHERLIKE-MIB IEEE8021-PAE-MIB IEEE8023-LAG-MIB	IF-MIB INET-ADDRESS-MIB OLD-CISCO-CHASSIS-MIB OLD-CISCO-FLASH-MIB OLD-CISCO-INTERFACES-MIB OLD-CISCO-IP-MIB OLD-CISCO-SYS-MIB OLD-CISCO-TCP-MIB OLD-CISCO-TS-MIB RFC1213-MIB RMON-MIB RMON2-MIB SNMP-FRAMEWORK-MIB SNMP-MPD-MIB SNMP-NOTIFICATION-MIB SNMP-TARGET-MIB SNMPv2-MIB TCP-MIB UDP-MIB	
	For an updated list of supported MIBs, refer to the MIB Locator at cisco.com/go/mibs.			

	8 port	16 port	24 port (1/10G uplinks)	48 port (1/10G uplinks)
Standards				
	IEEE 802.1D Spanning Tree Protocol IEEE 802.1p CoS Prioritization IEEE 802.1Q VLAN IEEE 802.1s IEEE 802.1w IEEE 802.1X IEEE 802.1ab (LLDP) Bluetooth Ver 4.0	IEEE 802.3ad IEEE 802.3af and IEEE 802.3at IEEE 802.3ah (100BASE-X single/multimode fiber only) IEEE 802.3x full duplex on 10BASE-T, 100BASE-TX, and 1000BASE-T ports IEEE 802.3 10BASE-T IEEE 802.3u 100BASE-TX	IEEE 802.3ab 1000BASE-T IEEE 802.3z 1000BASE-X RMON I and II standards SNMP v1, v2c, and v3 IEEE 802.3az IEEE 802.3ae 10 Gigabit Ethernet IEEE 802.1ax	
RFC compliance				
	RFC 768 - UDP RFC 783 - TFTP RFC 791 - IP RFC 792 - ICMP RFC 793 - TCP RFC 826 - ARP RFC 854 - Telnet RFC 951 - Bootstrap Protocol (BOOTP) RFC 959 - FTP RFC 1112 - IP Multicast and IGMP RFC 1157 - SNMP v1 RFC 1166 - IP Addresses	RFC 1256 - Internet Control Message Protocol (ICMP) Router Discovery RFC 1305 - NTP RFC 1492 - TACACS+ RFC 1493 - Bridge MIB RFC 1542 - BOOTP extensions RFC 1901 - SNMP v2C RFC 1902-1907 - SNMP v2 RFC 1981 - Maximum Transmission Unit (MTU) Path Discovery IPv6 FRC 2068 - HTTP RFC 2131 - DHCP RFC 2138 - RADIUS RFC 2233 - IF MIB v3		

Warranty

Cisco Catalyst 2960-L Switches come with an Enhanced Limited Lifetime Warranty (E-LLW). The E-LLW provides the same terms as the Cisco standard limited lifetime warranty but adds next-business-day delivery of replacement hardware, where available, and 90 days of 8x5 Cisco Technical Assistance Center (TAC) support. Your formal warranty statement, including the warranty applicable to Cisco software, appears in the Cisco information packet that accompanies your Cisco product. We encourage you to review carefully the warranty statement shipped with your specific product before use.

Cisco reserves the right to refund the purchase price as its exclusive warranty remedy. For more information about warranty terms, visit https://www.cisco.com/go/warranty and see Table 3. Warranty terms.

Cisco enhanced limited lifetime hardware warranty	
Device covered	Applies to all Cisco Catalyst 2960-L Series Switches and 2960-L Smart Managed Switches.
Warranty duration	As long as the original end user continues to own or use the product.
End-of-life policy	In the event of discontinuance of product manufacture, Cisco warranty support is limited to 5 years from the announcement of discontinuance.
Hardware replacement	Cisco or its service center will use commercially reasonable efforts to ship a Cisco Catalyst 2960-L replacement part for next-business-day delivery, where available. Otherwise, a replacement will be shipped within 10 working days after the receipt of the RMA request. Actual delivery times might vary depending on customer location.
Effective date	Hardware warranty commences from the date of shipment to customer (and in case of resale by a Cisco reseller, not more than 90 days after original shipment by Cisco).
TAC support	Cisco will provide during customer's local business hours, 8 hours per day, 5 days per week basic configuration, diagnosis, and troubleshooting of device-level problems for up to 90 days from the date of shipment of the originally purchased Cisco Catalyst 2960-L product. This support does not include solution or network-level support beyond the specific device under consideration.
Cisco.com access	Warranty allows guest access only to Cisco.com.

Licensing

Cisco Catalyst 2960-L Series Switches support term-based Cisco DNA Essentials licenses (Cisco DNA Essential). Table 4 lists the features supported in Cisco DNA Essentials. Table 5 gives ordering information for Cisco DNA Essentials with the 2960-L Series.

Ordering and managing licenses with smart accounts: Creating smart accounts by using the Cisco Smart Software Manager (SSM) enables you to order devices and licensing packages and also to manage your software licenses from a centralized website. You can set up Cisco SSM to receive daily email alerts and to be notified of expiring add-on licenses that you want to renew. When the license term expires, you can either renew the add-on license to continue using it or deactivate the add-on license and then reload the switch to continue operating with the base license capabilities.

Table 3. Features supported in Cisco DNA Essentials for Cisco Catalyst 2960-L Series Switches

Category	Features
Day-zero network bring-up automation	Cisco Network Plug-and-Play application
Cisco DNA Center	Discovery, inventory, topology, software image management
Network monitoring	Device 360

Software Policy

Customers with enhanced version of Cisco IOS LAN Lite software feature sets are provided with maintenance updates and bug fixes designed to maintain the compliance of the software with published specifications, release notes, and industry standards as long as the original end user continues to own or use the product or up to 1 year from the end-of-sale date for this product, whichever occurs earlier.

This policy supersedes any previous warranty or software statement and is subject to change without notice.

Technical Support and Services

Table 4 describes available technical services.

Table 4. Technical services available for Cisco Catalyst 2960-L Switches

Technical services
Cisco Smart Net Total Care™ Service • Around-the-clock, global access to the Cisco TAC • Unrestricted access to the extensive Cisco.com knowledge base and tools • Next-business-day, 8x5x4, 24x7x4, or 24x7x2 advance hardware replacement and onsite parts replacement and installation available[1] • Ongoing operating system software updates within the licensed feature set[2] • Proactive diagnostics and real-time alerts on Smart Call Home–enabled devices
Cisco Smart Foundation Service • Next-business-day advance hardware replacement as available • Access to SMB TAC during business hours (access levels vary by region) • Access to Cisco.com SMB knowledge base • Online technical resources through Smart Foundation Portal • Operating system software bug fixes and patches
Cisco Smart Care Service • Network-level coverage for the needs of small and medium-sized businesses • Proactive health checks and periodic assessments of Cisco network foundation, voice, and security technologies • Technical support for eligible Cisco hardware and software through Smart Net Total Care portal • Cisco operating system and application software updates and upgrades[2] • Next-business-day advance hardware replacement as available, 24x7x4 option available[1]
Cisco SP Base Service • Around-the-clock, global access to the Cisco TAC • Registered access to Cisco.com • Next-business-day, 8x5x4, 24x7x4, and 24x7x2 advance hardware replacement; return to factory option available1 • Ongoing operating system software updates[2]
Cisco Focused Technical Support Services Three levels of premium, high-touch services are available: • Cisco High-Touch Operations Management Service • Cisco High-Touch Technical Support Service • Cisco High-Touch Engineering Service Valid Cisco Smart Net Total Care or SP Base contracts are required on all network equipment.

[1] Advance hardware replacement is available in various service-level combinations. For example, 8x5xNBD indicates that shipment is initiated during the standard 8-hour business day, 5 days a week (the generally accepted business days within the relevant region), with Next-Business-Day (NBD) delivery. Where NBD is not available, same-day shipping is provided. Restrictions apply; for details, review the appropriate service descriptions.

[2] Cisco operating system updates include the following: maintenance releases, minor updates, and major updates within the licensed feature set.

Accessories

Table 5 describes the available accessories.

Table 5. Cisco Catalyst 2960-L Switches accessories

Part numbers	Description	Compatibility
CAB-CONSOLE-RJ45	Console Cable 6 Feet with RJ-45	All models
CAB-CONSOLE-USB	Console Cable 6 Feet with USB Type A and mini-B Connectors	All models
PWR-CLP	Power Cable Restraining Clip	All models
RCKMNT-1RU-2KX	1RU Rack Mount Kit for 2960-X, 2960-XR, and 2960-L	24-port and 48-port models only
RCKMNT-REC-2KX	Recessed 1RU rack mount for 2960X, 2960-XR, and 2960-L	24-port and 48-port models only
CMPCT-MGNT-TRAY	Magnetic Mounting Tray for 3560-CX, 2960-CX, and 2960-L Compact Switches	8-port and 16-port models only
CMPCT-CBLE-GRD	Cable Guard for 3560-CX, 2960-CX, and 2960-L Compact Switches	8-port and 16-port models only
CMPCT-DIN-MNT	DIN Rail Mount for 3560-CX, 2960-CX, and 2960-L Compact Switches	8-port and 16-port models only

Ordering Information

Table 6 lists ordering information for the Cisco Catalyst 2960-L Switches. To place an order, visit the Cisco Ordering homepage at https://www.cisco.com/en/US/ordering/or13/or8/order_customer_help_how_to_order_listing.html.

Table 6. Cisco Catalyst 2960-L Series Switches ordering information

Product number	Description
Cisco Catalyst 2960-L Switches with 2x 1G SFP uplinks	
WS-C2960L-8TS-LL	8 port 10/100/1000 Ethernet ports, 2 x 1G SFP
WS-C2960L-8PS-LL	8 port 10/100/1000 Ethernet PoE+ ports, 2 x 1G SFP
WS-C2960L-16TS-LL	16 port 10/100/1000 Ethernet ports, 2 x 1G SFP
WS-C2960L-16PS-LL	16 port 10/100/1000 Ethernet PoE+ ports, 2 x 1G SFP
Cisco Catalyst 2960-L Switches with 4x 1G SFP Uplinks	
WS-C2960L-24TS-LL	24 port 10/100/1000 Ethernet ports, 4 x 1G SFP
WS-C2960L-24PS-LL	24 port 10/100/1000 Ethernet PoE+ ports, 4 x 1G SFP

Product number	Description
WS-C2960L-48TS-LL	48 port 10/100/1000 Ethernet ports, 4 x 1G SFP
WS-C2960L-48PS-LL	48 port 10/100/1000 Ethernet PoE+ ports, 4 x 1G SFP
Cisco Catalyst 2960-L Switches with 4x 10G SFP+ Uplinks	
WS-C2960L-24TQ-LL	24 port 10/100/1000 Ethernet ports, 4 x 10G SFP+
WS-C2960L-24PQ-LL	24 port 10/100/1000 Ethernet PoE+ ports, 4 x 10G SFP+
WS-C2960L-48TQ-LL	48 port 10/100/1000 Ethernet ports, 4 x 10G SFP+
WS-C2960L-48PQ-LL	48 port 10/100/1000 Ethernet PoE+ ports, 4 x 10G SFP+

Table 7. Cisco Catalyst 2960-L Smart Managed Switches ordering information

Product number	Description
Cisco Catalyst 2960-L Smart Managed Switches with 2x 1G SFP uplinks	
WS-C2960L-SM-8TS	8 port 10/100/1000 Ethernet ports, 2 x 1G SFP
WS-C2960L-SM-8PS	8 port 10/100/1000 Ethernet PoE+ ports, 2 x 1G SFP
WS-C2960L-SM-16TS	16 port 10/100/1000 Ethernet ports, 2 x 1G SFP
WS-C2960L-SM-16PS	16 port 10/100/1000 Ethernet PoE+ ports, 2 x 1G SFP
Cisco Catalyst 2960-L Smart Managed Switches with 4x 1G SFP Uplinks	
WS-C2960L-SM-24TS	24 port 10/100/1000 Ethernet ports, 4 x 1G SFP
WS-C2960L-SM-24PS	24 port 10/100/1000 Ethernet PoE+ ports, 4 x 1G SFP
WS-C2960L-SM-48TS	48 port 10/100/1000 Ethernet ports, 4 x 1G SFP
WS-C2960L-SM-48PS	48 port 10/100/1000 Ethernet PoE+ ports, 4 x 1G SFP
Cisco Catalyst 2960-L Smart Managed Switches with 4x 10G SFP+ Uplinks	
WS-C2960L-SM-24TQ	24 port 10/100/1000 Ethernet ports, 4 x 10G SFP+
WS-C2960L-SM-24PQ	24 port 10/100/1000 Ethernet PoE+ ports, 4 x 10G SFP+
WS-C2960L-SM-48TQ	48 port 10/100/1000 Ethernet ports, 4 x 10G SFP+
WS-C2960L-SM-48PQ	48 port 10/100/1000 Ethernet PoE+ ports, 4 x 10G SFP+

Table 8. Product IDs for Cisco DNA Essentials licenses on the Cisco Catalyst 2960-L Series

Ports	Product ID	Description
8	C2960L-DNA-E-8=	C2960L Cisco DNA Essentials, 8-port term licenses
	C2960L-DNA-E-8-3Y	C2960L Cisco DNA Essentials, 8-port, 3-year term licenses
	C2960L-DNA-E-8-5Y	C2960L Cisco DNA Essentials, 8-port, 5-year term licenses
	C2960L-DNA-E-8-7Y	C2960L Cisco DNA Essentials, 8-port, 7-year term licenses
16	C2960L-DNA-E-16=	C2960L Cisco DNA Essentials, 16-port term licenses
	C2960L-DNA-E-16-3Y	C2960L Cisco DNA Essentials, 16-port, 3-year term licenses
	C2960L-DNA-E-16-5Y	C2960L Cisco DNA Essentials, 16-port, 5-year term licenses
	C2960L-DNA-E-16-7Y	C2960L Cisco DNA Essentials, 16-port, 7-year term licenses
24	C2960L-DNA-E-24=	C2960L Cisco DNA Essentials, 24-port term licenses
	C2960L-DNA-E-24-3Y	C2960L Cisco DNA Essentials, 24-port, 3-year term licenses
	C2960L-DNA-E-24-5Y	C2960L Cisco DNA Essentials, 24-port, 5-year term licenses
	C2960L-DNA-E-24-7Y	C2960L Cisco DNA Essentials, 24-port, 7-year term licenses
48	C2960L-DNA-E-48=	C2960L Cisco DNA Essentials, 48-port term licenses
	C2960L-DNA-E-48-3Y	C2960L Cisco DNA Essentials, 48-port, 3-year term licenses
	C2960L-DNA-E-48-5Y	C2960L Cisco DNA Essentials, 48-port, 5-year term licenses
	C2960L-DNA-E-48-7Y	C2960X Cisco DNA Essentials, 48-port, 7-year term licenses

Optics Compatibility Information

The Cisco Catalyst 2960-L Switches supports a wide range of optics. Because the list of supported optics is updated on a regular basis, consult the tables available here for compatibility information: Optics Compatibility.

Contact Cisco

For more information about Cisco products, contact:

Phone: +1 800 553-NETS (6387).

Worldwide Product Support.

Company website: cisco.com.

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Honeywell | MORLEY IAS FIRE SYSTEMS

Addressable Control Module

APPROVED

HM-DCMO-UL

UL LISTED

HM-DCMO-UL

General

The HM-DCMO-UL Addressable Control Module provides a circuit for Notification appliances like horns, strobes, and more. Addressability allows the HM-DCMO-UL to be activated through panel programming, on a select (zone or area of coverage) basis.

Applications

The HM-DCMO-UL is used to switch 24 VDC audible/visual power.

Construction

- The face plate is made of off-white, heat resistant plastic
- Controls include two rotary switches for direct-dial entry of address-setting
- The HM-DCMO-UL is configured for a single Class B Notification Appliance Circuit

Operation

Each HM-DCMO-UL uses one of the module addresses on a SLC loop. It responds to regular polls from the control panel and reports its type and status, including the open/normal/ short status of its Notification Appliance Circuit (NAC). The LED blinks with each poll received. On command, it activates its internal relay. The HM-DCMO-UL supervises Class B notification or control circuits.

Upon code command from the panel, the HM-DCMO-UL will disconnect the supervision and connect the external power supply in the proper polarity across the load device. The disconnection of the supervision provides a positive indication to the panel that the control relay turned ON. The external power supply is always relay-isolated from the communication loop, so that a trouble condition on the external power supply doesn't interfere with the rest of the system.

Rotary switches set a unique address for each module. The address may be set before or after mounting. The built-in TYPE CODE (not settable) of the control panel will identify the module, so as to differentiate between a module and a sensor address.

FEATURES & BENEFITS

- Built-in type identification automatically matches devices to the control panel
- Internal circuitry powered directly by a two-wire SLC loop The HM-DCMO-UL module requires power (for horns, strobes, etc.)
- Integral green LED blinks each time a communication is received from the control panel and turns on steady red when activated
- High noise immunity (EMF/RFI)
- The HM-DCMO-UL may be used to switch 24-volt NAC power
- Wide viewing angle of LED
- SEMS screws with clamping plates for easy wiring
- Direct-dial entry of address: 61 -99 for models SMX and STX

HM-DCMO-UL Technical Specifications

PARAMETER	SPECIFICATION
Normal operating voltage	15 to 32 VDC
Maximum SLC current draw	6.5 mA (LED on)
Average operating current	350 µA direct poll (CLIP mode) with LED flashing
External supply voltage	maximum 80 Volts (RMS or DC)
Drain on external supply	2 mA maximum (using internal EOL relay)
EOL resistance	47K ohms
Temperature range	32°F to 120°F (0°C to 49°C)
Humidity range	10% to 93% non-condensing
Dimensions	• 4.5" (11.43 cm) high x 4" (10.16 cm) wide x 1.25" (3.175 cm) deep • Mounts to a 4" (10.16 cm) square x 2.215" (5.398 cm) deep box

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **ULC**: S35595

Product Line Information

HM-DCMO-UL	Intelligent addressable control module
SMB500	Optional surface-mount backbox
CB500	Optional control module barrier, required by UL for separating power-limited and non-power-limited wiring in the same junction box as HM-DCMO-UL

NOTE: For installation instructions, see document CN-MN-0194 and refer to the SLC Wiring Manual.

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HM-DCMO-UL | Rev 01 | 08/19

APPROVED

SYSTEM SENSOR®

D4120
Duct Smoke Detector

The InnovairFlex™ Series are the only duct smoke detectors flexible enough to fit configurations from square to rectangular and everything in between.

InnovairFlex™

Features

- 4-Wire Photoelectric, integrated low-flow technology
- Air velocity rating from 100 ft/min to 4,000 ft/min (0.5 m/s to 20.32 m/sec)
- Versatile mounting options: square or rectangular configuration
- Plug-in sensor offers superb false alarm immunity and the latest sensor technology
- Broad ranges for operating temperature (–4°F to 158°F) and humidity (0% to 95% non-condensing)
- Patented sampling tube installs from front or back of the detector with no tools required
- Increased wiring space with a newly added ¾-inch conduit knockout
- One easy-access Test/Reset button and improved LED status
- Patented interconnect feature for multi-fan shutdown
- New high contrast terminal designations
- Built-in short circuit protection from operator wiring errors
- Field selectable settings for configuring the detector
- Two DPDT Form-C relay contacts
- 24 VAC/DC or 120 VAC
- Backward compatibility with existing Innovair products, including remote accessories

Agency Listings

UL LISTED S911

FM APPROVED 3033744

3242-1653:0207

The InnovairFlex D4120 4-wire photoelectric duct smoke detector features a pivoting housing that fits both square and rectangular footprints and mounts to round or rectangular ductwork. This unit senses smoke in the most challenging conditions, operating in airflow speeds of 100 to 4,000 feet per minute, temperatures of –4°F to 158°F, and a humidity range of 0 to 95 percent (non-condensing). A plug-in sensor head offers improved false alarm immunity and simple installation, testing, and maintenance. An improved cover design isolates the sensor head from the low-flow feature for simple maintenance.

The InnovairFlex housing provides ample wiring space, a ¾-inch conduit knockout, and built-in short circuit protection to prevent damage to sensitive components during installation. High contrast terminal designations make wiring easy. With its 2:1 sensor-to-power capability, the power board of the D4120 may be used to monitor a second sensor, D4S, simultaneously (i.e., supply and return side). As many as 50 InnovairFlex detectors can be interconnected. When one unit senses smoke, all interconnected detectors will switch their relays; only the detector sensing smoke will go into alarm, thus pinpointing the fire source.

An easy-access Test/Reset button makes it possible to test the unit with the cover on. Three DIP switches can be used to configure field selectable settings: cover tamper delay, number of sensors to be controlled, and shut down on trouble option. Each power board has two LEDs that can be used to indicate the status of connected sensors, and a quick reference imprinted on the cover explains the LED status indications (Standby, Maintenance, Trouble, and Alarm). The InnovairFlex duct smoke detector can be customized to meet local codes and specifications without additional wiring. The new InnovairFlex product line is compatible with all previous Innovair models, including remote test accessories.

WARNING: Duct smoke detectors are **NOT** a substitute for open area smoke detectors; **NOT** a substitute for early warning detection; **NOT** a replacement for a building's regular fire detection system. Refer to NFPA 72 and 90A for additional information.

InnovairFlex™ Duct Smoke Detector Specifications

Architectural/Engineering Specifications
The air duct smoke detector shall be a System Sensor InnovairFlex™ D4120 Photoelectric Duct Smoke Detector. The detector housing shall be UL listed per UL 268A specifically for use in air handling systems. The flexible housing of the duct smoke detector fits multiple footprints from square to rectangular. The detector shall operate at air velocities of 100 feet per minute to 4000 feet per minute (0.5 to 20.32 meters/second). The unit shall be capable of controlling up to 50 air handling systems when interconnected with other detectors. The detector shall be capable of providing a trouble signal in the event that the front cover is removed. It shall be capable of local testing via magnetic switch, test button on the cover, or remote testing using the RTS2-AOS Multi-Signaling Accessory or the RTS151KEY Remote Test Station. Terminal connections shall be of the strip and clamp method suitable for 12–18 AWG wiring.

Physical Specifications	
Size: (Rectangular Dimensions) **(Square Dimensions)**	14.38 in (37 cm) Length; 5 in (12.74 cm) Width; 2.5 in (6.36 cm) Depth 7.75 in (19.7 cm) Length; 9 in (22.9 cm) Width; 2.5 in (6.35 cm) Depth
Weight:	2.5 lbs (1.14 kg)
Operating Temperature Range:	D4120 & D4S: –4° to 158°F (–20° to 70°C); D4P120: –40° to 158°F (–40° to 70°C)
Storage Temperature Range:	D4120 & D4S: –22° to 158°F (–30° to 70°C); D4P120: –40° to 158°F (–40° to 70°C)
Operating Humidity Range:	0% to 95% relative humidity non-condensing
Air Duct Velocity:	100 to 4000 ft/min (0.5 to 20.32 m/sec)

Electrical Ratings			
Power supply voltage:	20–29 VDC	24 VAC 50–60 Hz	120 VAC 50–60 Hz
Input capacitance:	270 µF max.	270 µF max.	N/A
Reset voltage:	3.0 VDC min.	2.0 VAC min.	10 VAC min.
Reset time: (with RTS151)	.03 to 0.3 sec.	.03 to 0.3 sec.	.03 to 0.3 sec.
Reset time: (by power down)	0.6 sec. max.	0.6 sec. max.	0.6 sec. max.
Power up time:	35 sec. max.	35 sec. max.	35 sec. max.
Alarm response time:	15 sec.	15 sec.	15 sec.
Sensitivity Test:	See detector label	See detector label	See detector label
Current Requirements: (Using No Accessories)			
Max. standby current:	21 mA @ 24VDC	65 mA RMS @ 24VAC 60Hz	20 mA RMS @ 120VAC 60Hz
Max. alarm current:	65 mA @ 24VDC	135 mA RMS @ 24VAC 60Hz	35 mA RMS @ 120VAC 60Hz

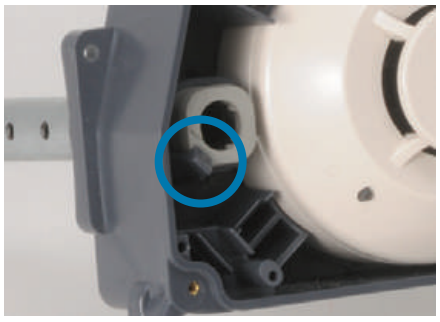
Contact Ratings	
Alarm initiation contacts: (SPST)	2.0A @ 30 VDC (resistive)
Alarm auxiliary contacts: (DPDT)	10A @ 30 VDC (resistive); 10A @ 250 VAC (resistive); ½ HP @ 240 VAC ; ¼ HP @ 120 VAC
Note: Alarm auxiliary contacts shall not be connected to initiating circuits of control panels. Use the alarm initiation contact for this purpose.	
Supervisory contacts: (SPDT)	2.0A @ 30 VDC (resistive); 2.0A @ 125 VAC (resistive)

Accessory Current Loads at 24 VDC			
Device	**Standby**	**Trouble**	**Alarm**
APA151	12.5 mA	n/a	30 mA Max.
MHR/MHW	0 mA	n/a	29 mA Max.
RA100Z	0 mA	n/a	12 mA Max.
RTS151/RTS151KEY	0 mA/12 mA	n/a	12 mA Max.
RTS2/RTS2-AOS	3.0mA max	16 mA Max.	with strobe: 55 mA max; without strobe 30 mA max

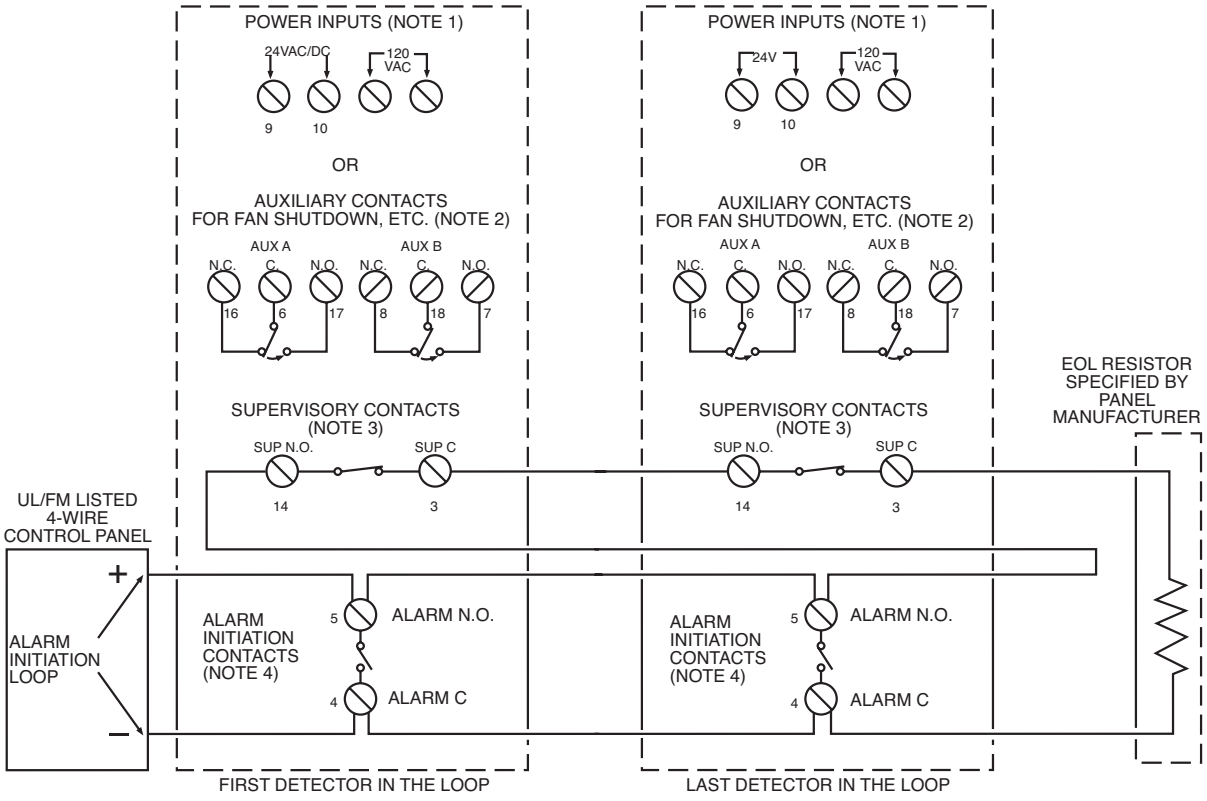
Note: Any combination of accessories may be used such that the given accessory loads are: 110 mA or less at the Aux output, and 50 mA or less at the Alarm output

Installing the InnovairFlex Sampling Tube

The InnovairFlex sampling tube may be installed from the front or back of the detector. The tube locks securely into place and can be removed by releasing the front or rear locking tab (front locking tab shown below right).



Wiring for 4-wire Duct Smoke Detector and Accessories



NOTE 1: 24V Power Inputs accept a non-polarized 24VDC or 24VAC 50-60Hz. 120VAC Power Inputs accept only 120VAC 50-60Hz. Connect power source to appropriate terminals of each detector. See specifications for additional power supply information.

NOTE 2: Auxiliary contacts shown in standby position. Contacts switch during alarm as indicated by arrows. Auxiliary contacts are not to be used for connection to the control panel. See specifications for contact ratings.

*Please refer to the corresponding installation manual for accessory wiring diagrams.

NOTE 3: Supervisory contacts shown in standby position. Open contacts indicate a trouble condition to the panel. See specifications for contact ratings.

NOTE 4: Alarm Initiation contacts shown in standby position. Closed contacts indicate an alarm condition to the panel. See specifications for contact ratings.

Important Notes on 2:1 Sensor-to-Power Capability

- 2:1 sensor-to-power capability is not available for all InnovairFlex models. The feature is only available on the D4120 4-wire conventional models.
- 2:1 sensor-to-power capability can be enabled using one D4120 and one D4S, or two D4S and one D4P120.

Important Interconnect Notes

- When using the interconnect feature, all interconnected units must be powered using the same independent supply.
- Polarity must be maintained throughout the interconnect wiring. Connect the INT+ terminal on unit 1 to the INT+ terminal on unit 2 and so on. Similarly, connect the INT/AUX– terminal on unit 1 to the INT/AUX- terminal on unit 2 and so on.
- Up to 50 D4120 units, 50 D4P120 units, or 50 units of combination may be interconnected.
- Up to 10 DH100ACDC units may be interconnected. Please note that each of the 9 DH100ACDC units interconnected may be replaced by three D4P120 units. Therefore, when using the interconnect feature a single DH100ACDC can drive either 9 DH100ACDCs or 27 D4120 units.

* NOTE: Alarm can be reset only at the initiating device and not at the devices interconnected.

Accessories

System Sensor provides system flexibility with a variety of accessories, including two remote test stations and several different means of visible and audible system annunciation. As with our duct smoke detectors, all duct smoke detector accessories are UL listed.

RTS151 UL S4011

RTS151KEY UL S2522

APA151 UL S4011

RTS2-AOS UL S2522

RA100Z UL S2522

MHW UL S4011

MHR UL S4011

AOS

Ordering Information

Part No.	Description		
D4120	4-wire photoelectric low-flow duct smoke detector		
Accessories			
D4S	4-wire photoelectric sensor component only	ETX	Metal exhaust tube duct width 1ft (0.3m)
D4P120	4-wire photoelectric power board component only, 24 VAC/DC, 120 VAC	M02-04-00	Test magnet
2D51	4-wire conventional photoelectric sensor head	MHR	Mini Horn, Red
DST1	Metal sampling tube duct width up to 1ft (0.3m)	MHW	Mini Horn, White
DST1.5	Metal sampling tube duct widths 1 ft to 2 ft (0.3 to 0.6 m)	P48-21-00	End cap for metal sampling tubes
DST3	Metal sampling tube duct widths 2 ft to 4 ft (0.6 to 1.2 m)	RA100Z	Remote annunciator alarm LED
DST5	Metal sampling tube duct widths 4 ft to 8 ft (1.2 to 2.4 m)	RTS151	Remote test station
DST10	Metal sampling tube duct widths 8 ft to 12 ft (2.4 to 3.7 m)	RTS151KEY	Remote test station with key lock
APA151	Remote annunciator with piezo alarm	RTS2 - AOS	Multi-signaling accessory with add on strobe

SYSTEM SENSOR®

3825 Ohio Avenue • St. Charles, IL 60174
Phone: 800-SENSOR2 • Fax: 630-377-6495
www.systemsensor.com

HVDS00502 • 10/13

Honeywell MORLEY IAS FIRE SYSTEMS | Addressable Fire Alarm Control Panel

Model: SMX

APPROVED

UL-LISTED

The SMX model is designed keeping in mind the needs of today's performance conscious establishments. It is a range of compact and feature-rich, modern-age panels that constitute together with a suite of intelligent devices, highly reliable fire alarm systems.

The SMX panels meet the requirements of the latest codes and standards and allow for quick and easy installation. Just fix the panel to the wall, connect the field wiring devices, and power up the panel for a working fire alarm system. The large touch display allows the panel to be programmed easily by providing a clear menu structure, making the the entire setup process extremely intuitive. Complex configuration is made easy by using the mobile appl and the Bluetooth dongle connectivity.

USER INTERFACE

Display: 5-inch multi-color touch display
Control Keys: Silence Buzzer, Silence/Resound Alarm, Reset
Indicators: Power, Alarm Silenced, Trouble, System Trouble, Disabled Test Supervisory, Delay

DEVICES AND LOOP CAPACITY

Supports Morley IAS UL detectors & modules
Loop Capacity: 500 mA per loop

SKU NO.	DESCRIPTION	NUMBER OF LOOP	COLOR	DEVICES	DEVICES / LOOP	ADDRESS RANGE	DEVICES / PANEL
915-100-202	SMX 1 loop panel supporting up to 198 devices in a grey color metal enclosure	1	Grey	Sensors	159	1 – 159	159
				Modules	39	161 – 199	39
915-100-102-R	SMX 1 loop panel supporting up to 198 devices in a red color metal enclosure	1	Red	Sensors	159	1 – 159	159
				Modules	39	161 – 199	39
915-100-202	SMX 2 loop panel supporting up to 396 devices in a grey color metal enclosure	2	Grey	Sensors	159	1 – 159	318
				Modules	39	161 – 199	78
915-100-202-R	SMX 2 loop panel supporting up to 396 devices in a red color metal enclosure	2	Red	Sensors	159	1 – 159	378
				Modules	39	161 – 199	78
915-100-402	SMX 4 loop panel supporting up to 792 devices in a grey color metal enclosure	4	Grey	Sensors	159	1 – 159	636
				Modules	39	161 – 199	156
915-100-402-R	SMX 4 loop panel supporting up to 792 devices in a red color metal enclosure	4	Red	Sensors	159	1 – 159	636
				Modules	39	161 – 199	156

KEY FEATURES

- Multiple loop options – 1, 2, and 4 loops
- Up to 198 devices per full loop
- 160 fire zones
- 10,000 events log
- Multiple output and input interfaces for a fully integrated fire alarm solution
- Pluggable electrical connectors and ergonomic design for easy installation
- Large touch display for enhanced readability, context-awareness and easy navigation resulting in exemplified user experience
- Mobile and PC apps for guided configuration
- Ability to configure panels off-site and sync via USB pen drive or Honeywell Bluetooth
- Battery-backed, real-time clock (RTC)
- 32-bit dual-core microprocessor
- UL 864 10th Edition Certified

SMX Technical Specifications

INTERFACES

- 3 Output Relays with single pole changeover 24V DC 1 A: Fire Trouble & Programmable (Supervisory by default)
- 1 RS485 port for up to 8 repeaters or mimics or a combination of the two
- 1 RS232 ports: One for serial printer
- 2 USB ports: One for pen drive and Honeywell Bluetooth dongle and one reserved for future use
- 2 NAC circuit with max 150 mA each
- 2 on-board monitored inputs

MECHNICAL	SPECIFICATIONS
DIMENSIONS [MM] (H X W X D)	531x451x178
WEIGHT (EXCLUDING BATTERIES)	9 kg (317 oz)
COLOUR	Grey & red
MOUNTING HOLES	5
KNOCKOUTS (20MM)	Top: 16; Bottom: 4; Side: 4; Back: 2
MOUNTING TYPE	Surface and Flush
OPERATING TEMPERATURE	0°C to +49°C
RELATIVE HUMIDITY	5% - 95% non-condensing
MATERIAL	Powder Coated Mild Steel.
IP RATING	30

ELECTRICAL	SPECIFICATIONS
OPERATING VOLTAGE	230V AC, 50/60 Hz
PSU RATING	24V DC 6.5 A
STAND-BY BATTERIES	2 loop (915-100-102) - 2 x 12Ah 4 loop (615-000-202) - 2 x 18 Ah or 2 x 24 Ah (based on battery back-up calculations)
STAND-BY BATTERY DURATION	24 hours back-up under normal condition
AUXILLIARY OUTPUT	2 units of 24 V Dc 100 mA each
FIELD STRENGTH	52V/m for 5W test condition

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S36244

For more information
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Toll Free: 1-800-103-0339
www.honeywell.com

SMX DS | Rev 01 | 08/19

Honeywell
MORLEY IAS FIRE SYSTEMS

7 It shall have a Built in signal processor
8 It shall be with 2 inbuilt fault isolators.(Detectors without Inbuilt Isolators may be considered with separate Isolator Base)

SE-UL

General

The HM-FHSE-UL, HM-RHSE-UL and HM-HTSE-UL Series thermal detectors are addressable sensors that use a state-of-the-art thermistor sensing circuit for fast response. These sensors provide protection for open areas and can be used use with addressable Fire Alarm Control Panels (FACPs).

The HM-FHSE-UL and HM-RHSE-UL sensors provide fixed temperature detection at 135°F (57°C). The HM-RHSE-UL sensor also responds to rate of rise conditions of greater than 15°F (8.3°C) per minute. The HM-HTSE-UL is a fixed, high-temperature detector that activates at 190°F (88°C). These thermal detectors provide addressable property protection for a variety of applications.

Comes with two LEDs on each sensor that provide a local, visible sensor indication. The remote LED annunciator capability is available using an optional accessory, the RA100Z..

HM-FHSE-UL

HM-RHSE-UL

HM-HTSE-UL

Installation

The HM-FHSE-UL Series of plug-in, intelligent thermal detectors use a detachable base to simplify installation, service, and maintenance. Installation instructions are shipped with each detector.

Mount base on an electrical backbox which is at least 1.5" (3.81 cm) deep. For a chart of compatible junction boxes, see DF-60059.

Application

Use thermal detectors for protection of property.

Construction

These detectors are constructed of off-white fire-resistant plastic. The HM-FHSE-UL Series plug-in, intelligent thermal detectors are designed to commercial standards and come with an appealing design.

Operation

Each HM-FHSE-UL Series detector uses one of 159 or 59 (Model: STX, 98 devices)possible addresses on a control panel SLC loop. It responds to regular polls from the control panel and reports type and status. If it receives a test command from the panel (or a local magnet test), the detector stimulates its electronics and reports an alarm. The LEDs blink when polled and the detector turns the LEDs on when commanded by the panel. The HM-FHSE-UL Series offer features and performance that represent the latest in thermal detector technology.

Honeywell

HM-FHSE-UL, HM-RHSE-UL HM-HTSE-UL THERMAL DETECTORS

FEATURES & BENEFITS

SLC Loops:
- Two-wire SLC loop connection
- Unit uses base for wiring

Addressing:
- Addressable by device
- Rotary, decimal addressing: 1- 159 for models SMX and STX

Architecture:
- Sleek, low-profile, stylish design
- State-of-the-art thermistor technology for fast response
- Integral communications and built-in device-type identification
- Built-in tamper resistant feature
- Built-in functional test switch activated by external magnet

Operation:
- Factory preset at 135°F (57°C) for the HM-FHSE-UL and HM-RHSE-UL; 190° F (88°C) for the HM-HTSE-UL
- Rate-of-rise triggers at 15°F (8.3°C) per minute for the H355R(A)
- 360-degree viewing angle of the visual alarm indicators. LEDs blink red in Normal condition and steadily illuminate red in Alarm
- Visible LEDs blink every time the unit is addressed

Mechanicals:
- Sealed against back pressure
- SEMS screws for wiring of the separate base
- Designed for direct-surface or electrical-box mounting
- Plugs into separate base for ease of installation and maintenance

Other system features:
- Remote test feature from the panel
- Walk test with address display
- Low standby current
- 94-5V plastic flammability rating

Options:
- Flanged surface mounting kit

Technical Specifications

PARAMETER	SPECIFICATION
Size	• 2.1" (5.3 cm) high; base determines diameter • B501: 4.1" (10.4 cm) diameter
Shipping weight	4.8 oz. (137 g)
Installation temperature	• HM-FHSE-UL, HM-RHSE-UL: –4°F to 100°F (–20°C to 38°C) • HM-HTSE-UL: –4°F to 150°F (–20°C to 66°C)
Humidity range	10% to 93% relative humidity (non-condensing)
Voltage range	15 to 32 VDC peak
Standby current	300 µA @24 VDC (one communication every five seconds with LED blink enabled)
LED current	6.5 mA @ 24 VDC
Fixed-temperature setpoint	135°F (57°C) for the HM-FHSE-UL and HM-RHSE- UL; 190°F (88°C) for the HM-HTSE-UL
Rate-of-rise detection	Responds to greater than 15°F (8.3°C) per minute

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S 36217

PRODUCT LINE INFORMATION	
HM-FHSE-UL	Intelligent thermal sensor; 135° F (57° C); B501 base included
HM-RHSE-UL	Same as HM-FHSE-UL with rate of rise feature; B501 base included
HM-HTSE-UL	Intelligent, fixed, high-temperature thermal detector; 190° F (88° C); B501 base included

ACCESSORIES	
SMB600	Surface mounting kit
M02-04-00	Test magnet
M02-09-00	Test magnet with telescoping handle
XR2B	Detector removal tool. Allows installation and/or removal of detector heads from bases in high ceiling applications
XP-4	Extension pole for XR2B. Comes in three, 5-foot (1.524 m) sections
T55-127-010	Detector removal tool without pole

For more information,
https://honeywellbuildings.in
Call: 1-800-103-0339
Email: HBT-Indiabuildings@honeywell.com

Honeywell HBT India Buildings
Unitech Trade Center, 5th Floor, Sector-43,
Block C, Sushant Lok Phase - I,
Gurgaon - 122 002

www.honeywell.com

APPROVED

SYSTEM SENSOR®

Selectable Output Horns, Strobes & Horn Strobes

System Sensor selectable output horns, strobes & horn strobes are rich with features guaranteed to reduce installation and maximize profits.

Features : Horn, Strobes & Horn Strobes

- Mounting plate included for compatibility with a wide range of back box sizes,
- Three field selectable candela settings: 15, 75, and 115,
- Easy to use rotary dials for selection of candela and horn settings,
- Built in synchronization feature keeps strobes in sync for up to 30 minutes,
- Strobes Listed to UL 1638; Horns Listed to UL 464,
- Horn settings on the horn strobe model include high and low volume, continuous or temporal 3 tone,
- Round trim ring available for ceiling mount applications,
- Universal Fire symbol is language independent,
- Trim plate allows mini horn to mount to a variety of backboxes and fit aesthetically with the horn strobe and strobe.

Features : Mini-Horn

- 12 and 24V operation,
- High and low volume settings,
- Temporal and non-temporal tones,
- Mounts to single gang back box,
- Compatible with MDL sunc module,
- Mechanically and electrically compatible with PA400 series Mini-Alert ™ sounders.

Agency Listing

SIGNALING

UL LISTED

The System Sensor line of notification devices offers the most flexible and easy-to-use line of horns, strobes, and horn strobes in the industry. With red housing, universal fire symbol and a ceiling mount accessory available these devices can meet virtually any application. They also mount to a wide variety of back box sizes to offer the most flexibility in installation.

This line of devices features a wide variety of features that simplifies installations. The mounting plate allows the devices to be compatible with a wide range of back box sizes. Settings for the strobe and horn are done using easy to set rotary switches on the back of the device. Synchronization is achieved without the use of additional modules; when powered with a filtered DC source, the strobe portion is capable of self synchronization for 30 minutes per NFPA 72.

Devices work on 24 volts DC or full wave rectified power. Three candela options are available for the strobe. On the horn strobe model, high and low volume are options for the horn as well as a continuous tone or temporal 3 output. The mini horn model has a continuous tone output and one volume setting.

Available accessories include a round trim ring to adapt the wall device for ceiling mount applications. Simply install the round ring over the square device for a perfect fit on the ceiling. An adapter plate is also available for the mini horn. It fits to a wider range of back boxes and fits with the family look of the horn strobe and strobe devices.

System Sensor Specifications

Architect/Engineer Specifications

General

System Sensor strobe and horn strobes shall mount to a 2"x4", 4"x4", Single Gang, Double Gang, 4" Octagon, 3.7" x 3.7", 2" round, 2.36" x 2.36", 3.54" x 2.6", 1.77" back box. System Sensor devices shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 24 volts. 24-volt-rated notification appliance circuit outputs shall operate between 17 and 33 volts. Devices operate between 32 and 120 degrees Fahrenheit from a regulated DC or full-wave rectified unfiltered power supply. Strobes and horn strobes shall have field-selectable candela settings including 15, 75 and 115 cd. The devices shall not operate on a coded power supply. Horn - strobe and strobe devices shall have built-in synchronization capability. Upon initial power up the devices shall be synchronized for up to 30minutes.

Strobe

The strobe shall be a System Sensor Model SYS-ST or SYS-ST-C listed to UL 1638 and shall be approved for fire protective service. The strobe shall be wired as a primary signaling notification appliance flashing at 1 Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system.

Horn Strobe Combination

The horn strobe shall be a System Sensor Model listed to UL 1638 and UL 464 and shall be approved for fire protective service. The horn strobe shall be wired as a primary-signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have two audibility options and an option to switch between a temporal three-pattern and a non-temporal (continuous) pattern. These options are set by a multiple position switch.

Mini Horn

Mini-horns shall be a System Sensor Model MHR or MHW capable of operating at nominal 12 or 24VDC and shall mount to a deep single gang back box. Minihorn shall be listed to Underwriter's Laboratories Standard UL464 for fire protective signaling systems. Mini-horns shall operate between 32 and 120 degrees Fahrenheit from a regulated DC, or full-wave rectified, unfiltered power supply. When used with the Sync•Circuit™ Module, 12-volt rated notification appliance circuit outputs shall operate between nine and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 17 and 33 volts.

Physical/Electrical Specifications: Horn, Strobes & Horn Strobes	
Standard Operating Temperature	32°F to 120°F (0°C to 49°C)
Humidity Range	10 to 93% non-condensing
Strobe Flash Rate	1 flash per second
Nominal Voltage	Regulated or regulated 24 DC/FWR1
Operating Voltage Range2	16 to 33 V (24 V nominal)
Input Terminal Wire Gauge	14 to 18 AWG*
Strobe and horn strobes dimensions(including lens)	5.15" L x 5.0"Wx 1.5" D (131mmx 127mmx 38mm)
Ceiling trim ring dimensions (sold as a pack of 5)	6.8 " dia / 1.5" depth (173mmdia / 1.5" depth)

Mini-Horn UL Sound Output and Current Draw Data

Sounder Output (dBA)								
Switch Setting	Pattern	Output Level	8–17.5 VDC	8–17.5 VFWR	Nominal 12 VDC	Nominal 12 VFWR	16–33 VDC	16–33 VFWR
1	Temporal	High	68	67	71	70	78	76
2	Temporal	Low	66	65	69	68	76	75
3	Non-temporal	High	72	71	75	74	80	79
4	Non-temporal	Low	70	69	73	72	78	77

Sounder Current Draw (mA RMS)						
			8–17.5 Volts		16–33 Volts	
Switch Position	Sound Pattern	Volume	DC	FWR	DC	FWR
1	Temporal	High	12	10	17	15
2	Temporal	Low	10	9	14	13
3	Non-temporal	High	22	17	29	25
4	Non-temporal	Low	17	13	21	19

Full Wave Rectified (FWR) voltage is a non-regulated, time-varying power source that is used on some power supply and panel outputs.

UL Current Draw Data

UL Max. Strobe Current Draw (mA RMS)

			16–33 Volts	
	Switch Position	Candela	DC	FWR
Standard Candela Range	Position 1	15	34	45
	Position 2	75	63	74
	Position 3	115	79	89

UL Max. Current Draw Horn Strobe

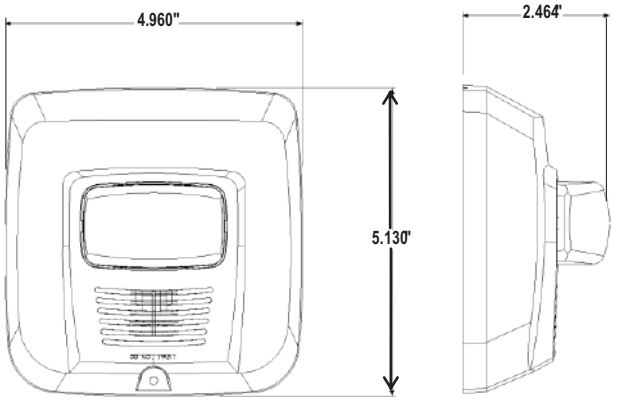
	16–33 Volts		
DC Input	15	15/75	30
Temporal High	36	67	84
Temporal Medium	34	65	82
Continuous High	40	72	90
Continuous Low	37	68	85
FWR Input			
Temporal High	51	77	83
Temporal Low	49	75	92
Continuous High	55	82	98
Continuous Low	50	78	94

Horn Tones and Sound Output Data

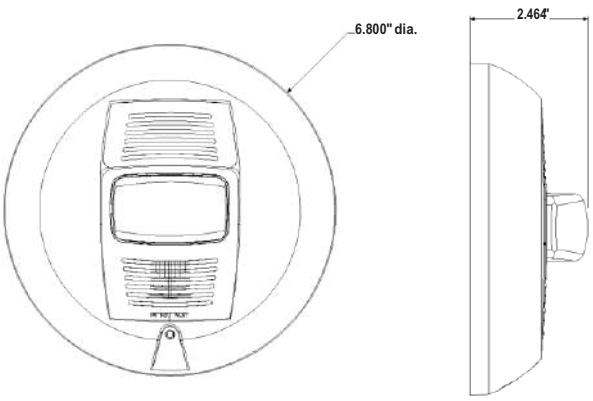
Horn Strobe Output (dBA)

					24-Volt Nominal			
			16–33 Volts†		Reverberant		Anechoic	
Switch Position	Sound Pattern	dB	DC	FWR	DC	FWR	DC	FWR
1	Temporal	High	78	77	78	77	100	104
2	Temporal	Low	74	73	74	73	103	101
3	Continuous	High	82	80	82	80	100	104
4	Continuous	Low	80	78	80	78	103	101

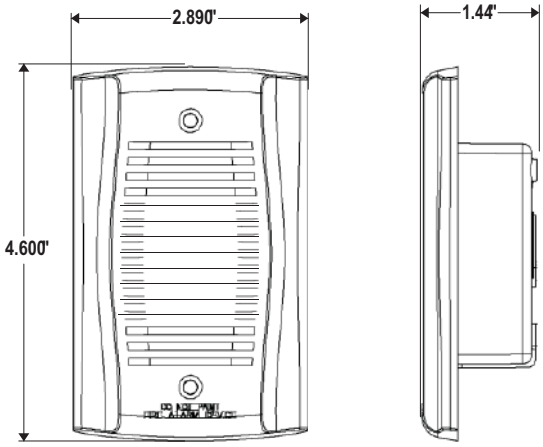
†Minimum dB rating for Operational Voltage Range as per UL 464.



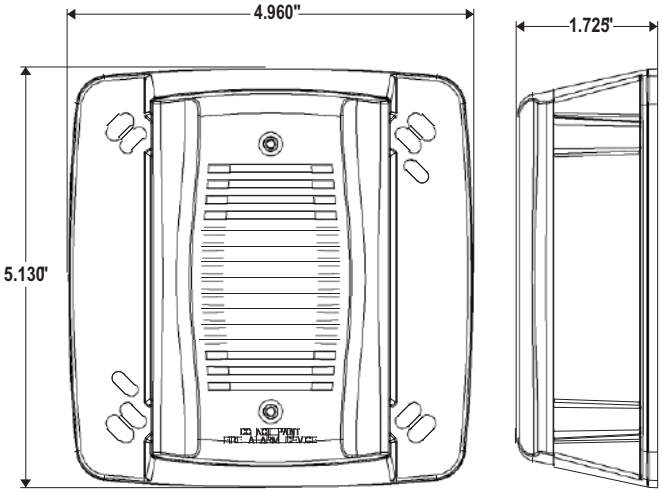
Wall Mount Horn Strobe Product



Ceiling Mount Horn Strobe



Mini Horn



Mini Horn with Optional Trim Plate

System Sensor Ordering Information

Model	Description
Wall Horn Strobes	
SYS-HS	Horn Strobe, Wall Mount
SYS-HS-C	Horn Strobe, Ceiling Mount
Wall Strobes	
SYS-ST	Strobe, Wall Mount
SYS-ST-C	Strobe, Ceiling Mount
SYS-CTP	Ceiling Mount Trim Plate

Model	Description
Mini Horn	
MHR1	Mini-Horn, Red
SYS-MH-TP	Trim Ring for use with the Mini Horn

Tech Support : Support.ssi@honeywell.com
Sec 36- Pace City – II, Gurgaon, Haryana- 122004
Phone: (0124) 4752700 • Fax: (0124) 6722700

It shall be with inbuilt fault isolators with Detectors, Multi-Criteria Detector - Smoke, Heat, Optical etc.

MODULE

LISTED

General

The HM-DISO-UL Fault Isolator Module is used with the fire alarm control panels (FACPs) to protect the system against wire-to-wire short circuits on the SLC loop. The HM-DISO-UL should be placed between each device on the SLC loop to isolate a short circuit problem between the modules. It is required for true Style 7 operation, so that other devices can continue to operate normally in the event of a short circuit on the SLC.

HM-DISO-UL

Applications

The Fault Isolator Modules should be spaced between groups of sensors in a loop to protect the rest of the loop. The HM-DISO-UL supports a maximum of 25 devices in between isolators.

FEATURES & BENEFITS

- Powered by SLC loop directly, no external power required
- Mounts in standard junction boxes (4.0”/10.16 cm square, 2.125”/5.398 cm deep)
- Integral LED blinks to indicate normal condition and illuminates steady when short circuit condition is detected
- High noise (EMF/RFI) immunity

Honeywell

HM-DISO-UL Technical Specifications

PARAMETER	SPECIFICATION
Operating voltage	15 – 32 VDC (peak)
Maximum current upon activation due to short circuit	Refer to the manual for the main FACP
Standby current	450 µA maximum; HM-DISO-UL is not isolated through a closed relay
Temperature range	32°F to 120°F (0°C to 49°C)
Relative humidity	10% to 93%
Weight	5 oz. (150 grams)
Dimensions	4.5"H x 4.5"W x 0.25" D (11.43 cm H x 11.43 cm W x 0.635 cm D)

Construction

The face plate is made of off-white plastic. Module includes yellow LED indicator that pulses to indicate normal conditions and illuminates steady when a short is detected.

Operation

The circuit is automatically opened when the voltage line drops below four volts. Fault Isolator Modules should be spaced between groups of addressable devices (maximum 25), in a loop that protects the rest of the loop. If a short occurs between any two isolators, then both isolators immediately switch to an open circuit state and isolate the groups of sensors between them. The remaining units on the loop continue to fully operate.

The HM-DISO-UL Fault Isolator Module automatically restores the shorted portion of the communications loop to normal.

Installation

- Mount on a standard junction box (4.0"/10.16 cm square) which is at least 2.125"/5.398 cm deep
- Terminal screws are provided for "in and out" wiring
- Installation instructions are provided with each module
- Surface mount box available

Engineering Specifications

Fault Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Fault Isolator Module limits the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. If a wire-to-wire short occurs, the Fault Isolator Module automatically disconnects the SLC loop. When the short circuit condition is corrected, the Fault Isolator Module automatically reconnects the isolated section of the SLC loop. The Fault Isolator Module doesn't require any address, as operations switch to automatic mode. Replacing or resetting the Fault Isolator Module is not required, after operating normally. The Fault Isolator Module shall mount in a standard 4" (10.16 cm) deep electrical box, in a surface mounted backbox, or in the Fire Alarm Control Panel. It provides a single LED that flashes when the Isolator is operational and illuminates steadily to indicate that a short circuit condition has been detected and isolated.

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S35595

Product Line Information

PARAMETER	SPECIFICATION
HM-DISO-UL	Isolator module
SMB500	Optional surface-mount backbox

For more information,
https://honeywellbuildings.in
Call: 1-800-103-0339
Email: HBT-Indiabuildings@honeywell.com

Honeywell HBT India Buildings
Unitech Trade Center, 5th Floor, Sector-43,
Block C, Sushant Lok Phase - I,
Gurgaon - 122 002

www.honeywell.com

HM-DISO-UL
FAULT ISOLATOR MODULE

Honeywell

Honeywell MORLEY IAS FIRE SYSTEMS | Manual Call Point

APPROVED

HM-MCP-GLASS-UL

UL LISTED

General

The HM-MCP-GLASS-ULis an addressable manual break glass call point which, as a simple rotary decade, switch at the rear of the unit for addressing.

A specialist test key may be inserted into the bottom of the unit to lower the glass and release the micro-switch – enabling a complete functionality test.

The HM-MCP-GLASS- UL call point is designed to provide a manual alarm interface to Morley IAS's fire alarm control panel.

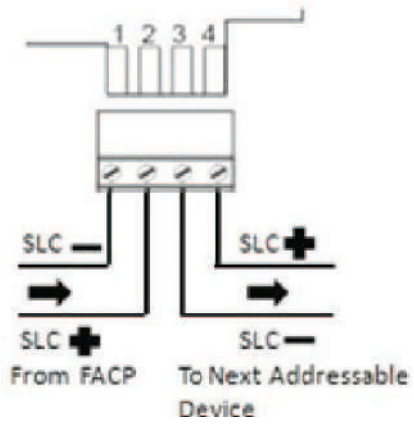
Installation efficiency and compliance with the latest standards are at the heart of the call point range.

HM-MCP-GLASS-UL

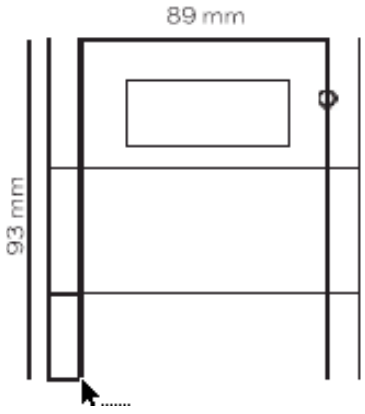
LED Status

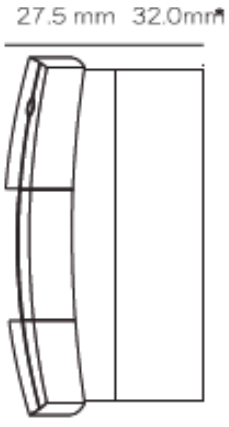
The LED status is controlled by the fire panel and shows blinking RED each time the device is polled, or continuous RED to indicate fire detection.

Connection Details



Dimensions





FEATURES & BENEFITS

- Innovative "Plug and Play" installation concept
- Analogue addressable communications
- Integral LED

HM-MCP-GLASS-UL Technical Specifications

Mechnical Specifications

PARAMETER	SPECIFICATION
Dimensions	• Semi-flush mounting: 89 x 93 x 27.5 (WxHxD) • Surface mounting: 89 x 93 x 59.5 (WxHxD)
Weight	110g (3.8 oz.)
IP Rating	IP24D
Operating Temperature	0°C to 49°C (32°F – 120°F)
Relative Humidity	10% - 93% non-condensing

Electrical Specifications

PARAMETER	SPECIFICATION
Operating Voltage	15V to 32Vdc max
Current Consumption	Quiescent (without isolator) 385μA Alarm Current: 7.8 mA

Optional Accessories

PART CODE	DESCRIPTION
PS230	Pack of 10 resettable elements
MUS041W	Manual call point back box
MUS156	Pack of 10 glass elements
SC070	Pack of 10 test keys

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S36215

Product Line Information

HM-MCP-GLASS-UL: Addressable break glass manual call point

Honeywell Building Technologies ASEAN
Level 25, UOA Corp Tower B, Avenue 10
The Vertical, Bangsar South City
59200, Kuala Lumpur, Malaysia
Email: Buildings.ASEAN@Honeywell.com

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Phone: +971 4 4505 847

Honeywell Building Technologies India
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Toll Free: 1-800-103-0339
www.honeywell.com

Honeywell
MORLEY IAS FIRE SYSTEMS

Honeywell | MORLEY IAS FIRE SYSTEMS

Multi-Sensing Detector

APPROVED

HM-PTSE-UL

UL LISTED

General

The HM-PTSE-UL detector is an intelligent, addressable, multi-sensing, low-profile detector designed for Fire Alarm Control Panels.

The detector uses a combination of photoelectric and thermal sensing technologies to reduce to false alarms. Unlike traditional intelligent detectors, it has a microprocessor that processes alarm data. As a result, the detector adjusts its sensitivity automatically, without operator intervention or control panel programming.

Areas where the detector is especially useful include office complexes, schools, college campuses, manufacturing, and industrial facilities, and anywhere else where the use of a particular area may change. The detector automatically adjusts its sensitivity to the environment.

HM-PTSE-UL

NOTE: Avoid installing these detectors in locations that are susceptible to rapid and high temperature changes. An example of an incorrect application would be near or in line with the output of a self-contained heater.

Installation

The HM-PTSE-UL plug-in detector uses a separate base to simplify installation, service, and maintenance. A special tool allows maintenance personnel to plug-in and remove detectors without using a ladder. Suitable mounting base boxes include:

- 4.0" (10.16 cm) square box
- 3.5" (8.89 cm) or 4.0" (10.16 cm) octagonal box
- Single-gang box (except relay or isolator base)

FEATURES & BENEFITS

- Automatically adjusts sensitivity levels without operator intervention or programming
- Sensitivity increases with heat
- Microprocessor-based, combination photo and thermal technology
- Addressable-analog communication
- Sleek, low-profile design
- Two-wire SLC connection
- Addressing:
  - Addressable by device
  - Rotary, decimal addressing: 1- 159 for models SMX and STX
- Addresses can be viewed and changed without electronic programmers
- Dual bi-color LED design provides 360° viewing angle
- LEDs lock red when in alarm.
- Built-in, tamper-resistant feature
- Constructed of off-white, fire-resistant plastic, designed to commercial standards, and offers an attractive appearance
- SEMS screws for wiring of the separate base
- Several base options, including relay, isolator, and sounder
- Built-in functional test switch activated by external magnet
- Listed to UL 268

HM-PTSE-UL Technical Specifications

TECHNICAL SPECIFICATIONS	
Parameter	**Specification**
Sensitivity fixed-sensitivity levels	1, 2, and 4%/ft with classic CLIP systems
Size	• 2.0" (53 cm) height, base determines daimete • B501: 4.1" (10.4 cm) diameter
Shipping weight	5.2 oz (147g)
Operating temperature	0°C to 38°C (32°F to 100°F)
UL-Listed velocity range	0 – 4000 ft./min. (1219.2 m/min.), suitable for installation in ducts
Relative humidity	10% – 93% non-condensing
Thermal sensing rating	fixed-temperature setpoint 135°F (57°C)

ELECTRICAL SPECIFICATIONS	
Parameter	**Specification**
Voltage range	15 – 32 volts DC peak
Standby current (max. avg.)	300 µA
Loop resistance	50 ohms maximum; varies according to control panel used. Refer to panel installation manuals
LED current (max.)	6.5 mA @ 24 VDC ("ON")

ACCESSORIES	
SMB600	Surface mounting kit
M02-04-00	Test magnet
M02-09-00	Test magnet with telescoping handle
XR2B	Detector removal tool. Allows installation and/or removal of detector heads from bases in high ceiling applications
T55-127-010	Detector removal tool without pole
XP-4	Extension pole for XR2B. Comes in three 5-foot (1.524m) sections

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed**: S36216

Product Line Information

HM-PTSE-UL: Low-profile, intelligent, multi-sensor detector

Honeywell Building Technologies ASEAN
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Toll Free: 1-800-103-0339
www.honeywell.com

87045 LIMOGES Cedex France
Telephone: (+33) 05 55 06 87 87 - Fax: (+33) 05 55 06 88 88

Cat. 6 PVC cords

Catalogue numbers: **0 517 52/53/54/55/62/63/64/65**
0 517 72/7374/75

APPROVED

1. USE

Cords for VDI transmission networks.
Straight RJ45 - RJ45 (cable with multicore cords).
Blue RAL 5015.

2. RANGE

Cat. Nos.	Length (m)	Type	Type of sleeve
0 517 72	1	U/UTP	PVC
0 517 73	2		
0 517 74	3		
0 517 75	5		
0 517 62	1	F/UTP	
0 517 63	2		
0 517 64	3		
0 517 65	5		
0 517 52	1	S/FTP	
0 517 53	2		
0 517 54	3		
0 517 55	5		

3. CORD MARKINGS

- LEGRAND
- Catalogue number
- Gauge
- Type
- Impedance
- Type of sleeve
- Category

4. PERFORMANCE AT 250 MHZ

Standards IEC 61935-2 - Ed. 3.0
ISO/IEC 11801

Length (m)	Minimum NEXT (dB)	Return Loss (dB)
1	39.1	14.0
2	38.7	
3	38.3	
5	38.0	

5. TECHNICAL AND MECHANICAL FEATURES

Type	U/UTP	F/UTP	S/FTP
Type of sleeve	PVC		
Number of pairs	4		
Assembly	Pairs		
Diameter over insulation (mm)	0.97	0.92	1.02
Cable diameter (mm)	6	6	5.7 ± 0.2
AWG gauge	24	26	27
Min. bending radius when laying (mm)	24	24	24
Tensile strength of the cord	≥ 50 N	≥ 50 N	≥ 50 N
Number of twists	500	500	500
Number of insertions	750	750	750

6. ELECTRICAL FEATURES AT 20°C

Loop resistance	< 2 Ω
Contact resistance	< 20 mΩ
Total resistance of the cord	< 5 Ω
Resistance per 100 m of cable with cords	< 14 Ω
DC dielectric strength	1 KV/1 min
Characteristic impedance from 1 to 250 MHz	100 Ω ± 15

7. ENVIRONMENTAL FEATURES

Storage and transport temperature: 0 to + 50°C
Usage temperature: – 20 to + 60°C
Fire resistance: IEC 60332-1, UL VW-1

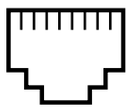
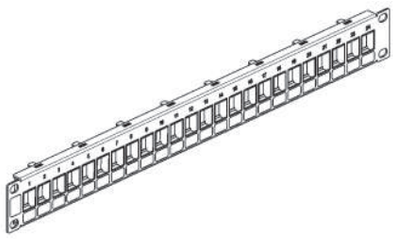
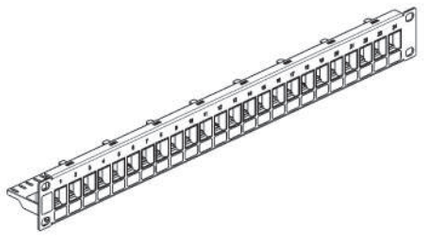
8. STANDARDS AND APPROVALS

EN 50173
ISO/IEC 60603-7
ISO/IEC 11801

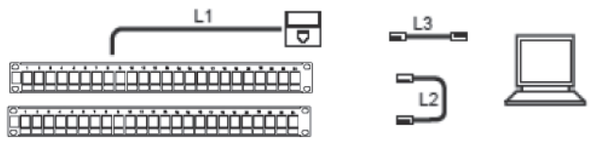
Patch Panel
6 327 90 - 6 327 91

APPROVED

legrand®

UTP 	**Cat. 5e** **Cat. 6**	 **6 327 90**  **6 327 91**

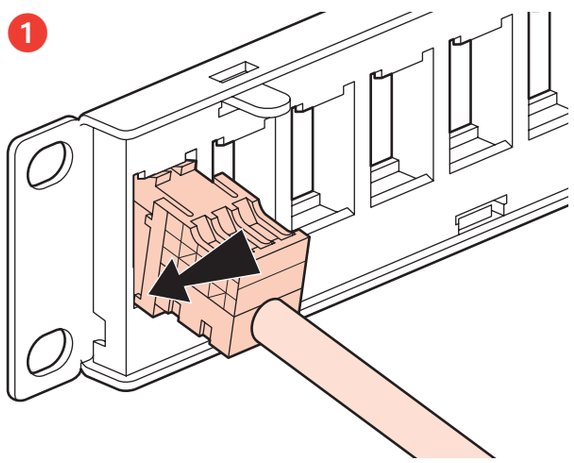
- **Installation**
- **Installation**
- **Instalación**
- **Instalação**
- **Установка**
- التنصيب

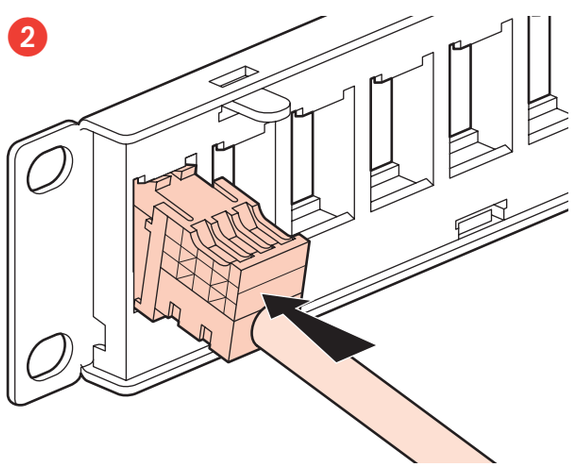


Cat. 5e	L1 ≤ 90 m
Cat. 6	L2 + L3 ≤ 10 m

- **Montage**
- **Mounting**
- **Montaje**
- **Montagem**
- **Монтаж**
- التركيب

6 327 90

1 

2 

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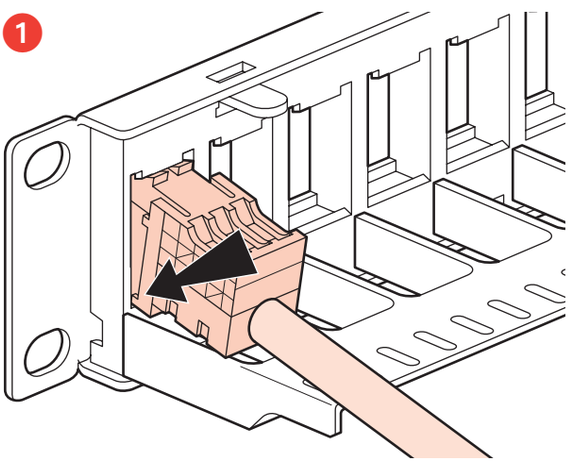
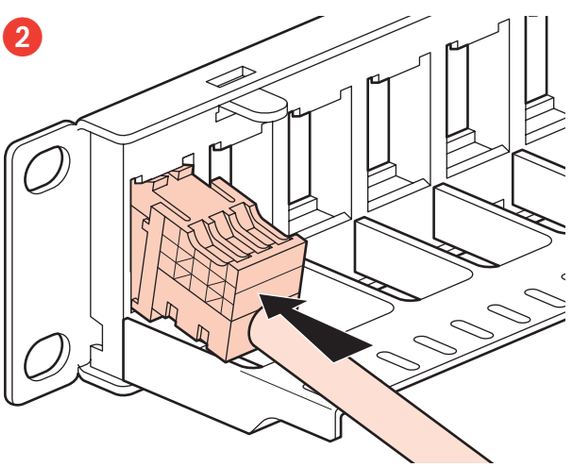
1 

2 

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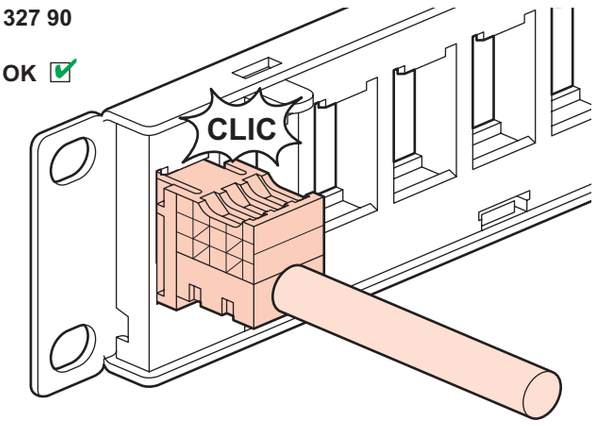
OK ☑



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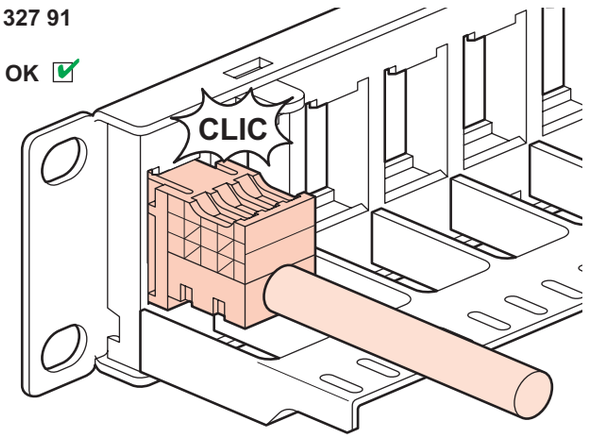
OK ☑



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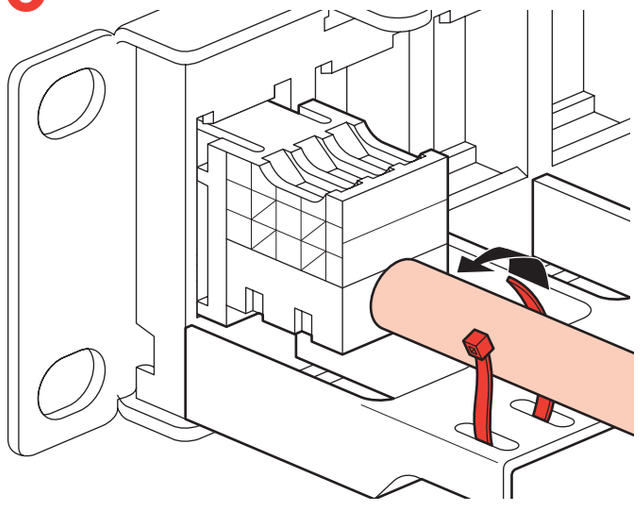

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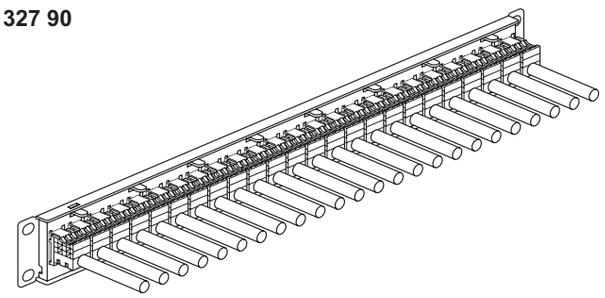

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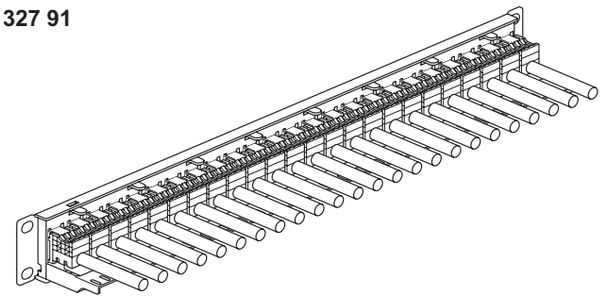

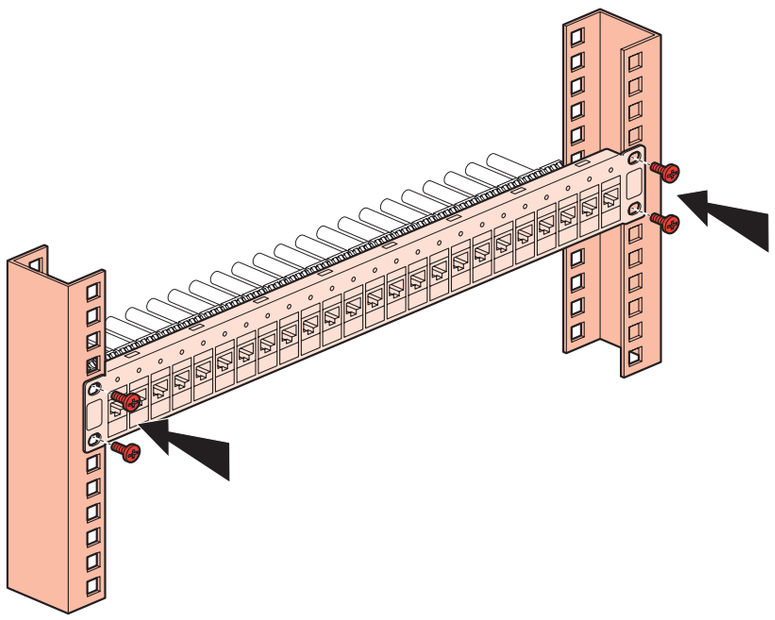

- **Démontage**
- **Disassembly**
- **Desmontaje**
- **Desmontagem**
- **Демонтаж**
- التفكيك

OK ☑

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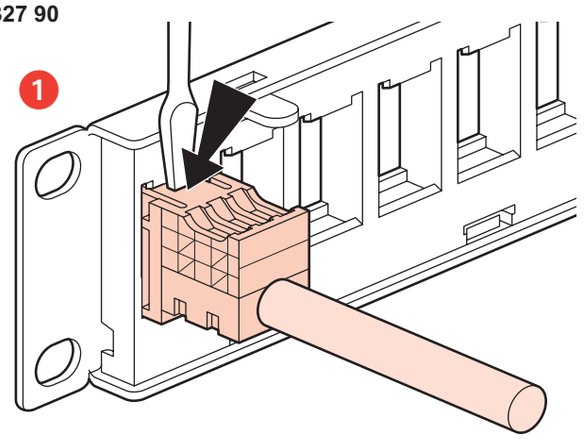

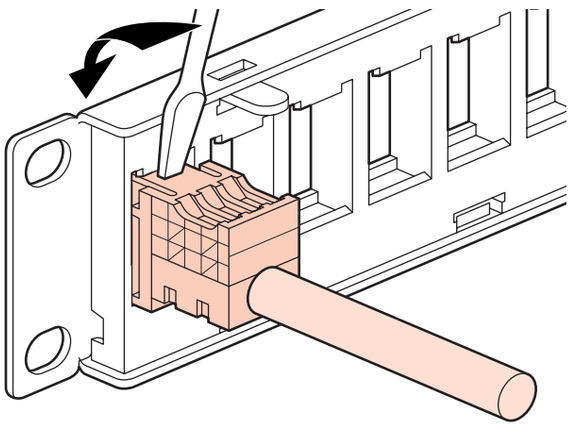

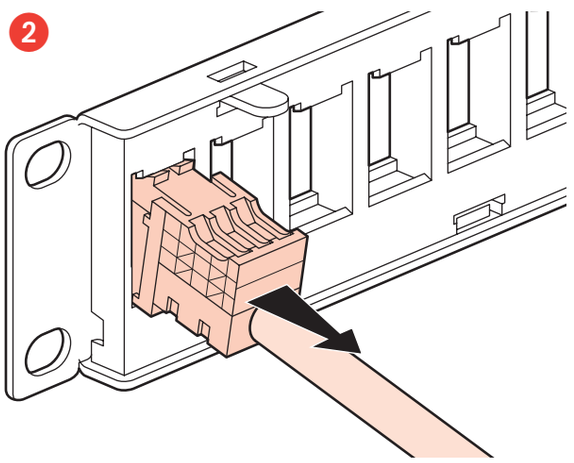

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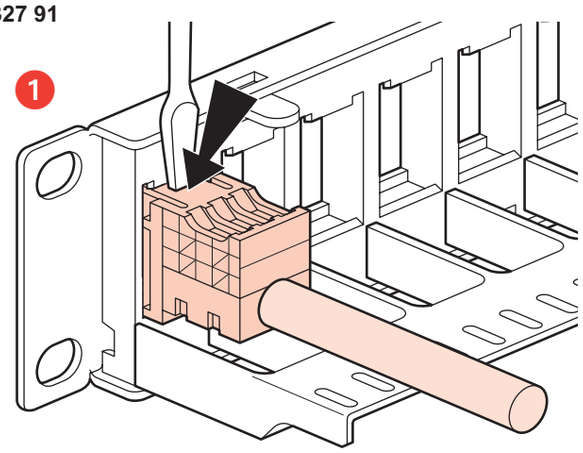

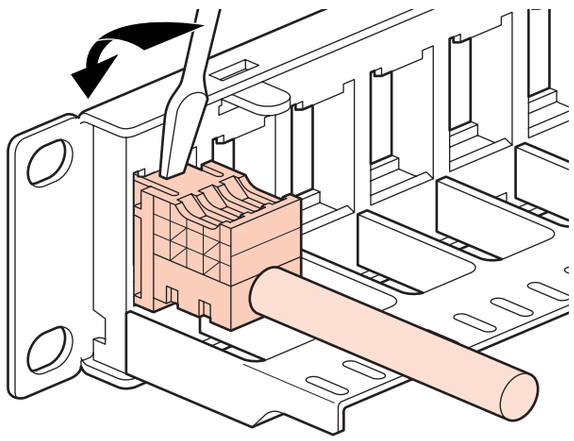

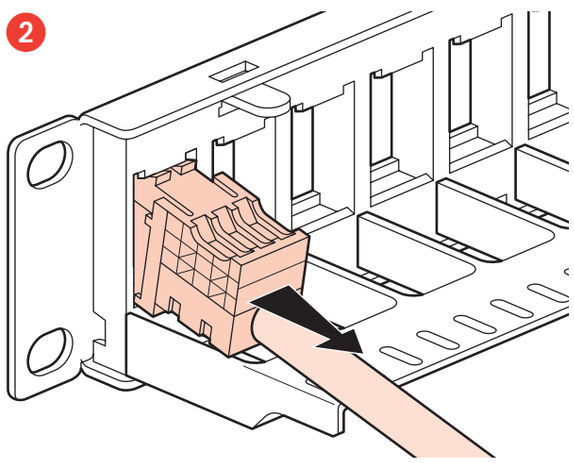

Consignes de sécurité (FR)

Ce produit doit être installé conformément aux règles d'installation et de préférence par un électricien qualifié. Une installation et une utilisation incorrectes peuvent entraîner des risques de choc électrique ou d'incendie. Avant d'effectuer l'installation, lire la notice, tenir compte du lieu de montage spécifique au produit.
Ne pas ouvrir, démonter, altérer ou modifier l'appareil sauf mention particulière indiquée dans la notice. Tous les produits Legrand doivent exclusivement être ouverts et réparés par du personnel formé et habilité par Legrand. Toute ouverture ou réparation non autorisée annule l'intégralité des responsabilités, droits à remplacement et garanties.
Utiliser exclusivement les accessoires de la marque Legrand.

Safety instructions (GB)

This product should be installed in line with installation rules, preferably by a qualified electrician. Incorrect installation and use can lead to risk of electric shock or fire.
Before carrying out the installation, read the instructions and take account of the product's specific mounting location.
Do not open up, dismantle, alter or modify the device except where specifically required to do so by the instructions. All Legrand products must be opened and repaired exclusively by personnel trained and approved by Legrand. Any unauthorised opening or repair completely cancels all liabilities and the rights to replacement and guarantees.
Use only Legrand brand accessories.

Consignas de seguridad (ES)

Este producto debe instalarse conforme a las normas de instalación y preferiblemente por un electricista cualificado. Una instalación y una utilización incorrectas pueden entrañar riesgos de choque eléctrico o de incendio. Antes de efectuar la instalación, leer las instrucciones, tener en cuenta el lugar de montaje específico del producto.
No abrir, desmontar, alterar o modificar el aparato salvo que esto se indique específicamente en las instrucciones. Todos los productos Legrand deben ser abiertos y reparados exclusivamente por personal formado y habilitado por Legrand. Cualquier apertura o reparación no autorizada anula la totalidad de las responsabilidades, derechos a sustitución y garantías.
Utilizar exclusivamente los accesorios de la marca Legrand.

Instruções de segurança (PT)

Este produto deve ser instalado de acordo com as regras de instalação e de preferência por um electricista qualificado. A instalação e o uso incorrectos podem provocar riscos de choque eléctrico ou de incêndio.
Antes de efectuar a instalação, ler as instruções e ter em conta a localização adequada para a montagem do produto.
Não abrir, desmontar, alterar ou modificar o aparelho salvo especificação em contrário nas instruções do produto. Todos os produtos Legrand só devem ser abertos e reparados exclusivamente por pessoal formado e autorizado pela Legrand. Qualquer abertura ou reparação não autorizada cancela todas as responsabilidades, direitos de substituição e garantias.
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Меры предосторожности (RU)

Установка данного изделия должна выполняться в соответствии с правилами монтажа и предпочтительно квалифицированным электриком. Неправильный монтаж или нарушение правил эксплуатации изделия могут привести к возникновению пожара или поражению электрическим током.
Перед монтажом необходимо внимательно ознакомиться с данной инструкцией, а также принять во внимание требования к месту установки изделия. Запрещается вскрывать корпус изделия, а также разбирать, выводить из строя или модифицировать изделие, кроме случаев, оговоренных в инструкции. Вскрытие и ремонт изделий марки Legrand могут выполняться только специалистами, обученными и допущенными к таким работам компанией «ЛЕГРАН». Несанкционированное вскрытие или выполнение ремонтных работ посторонними лицами лишает законной силы любые требования об ответственности, замене или гарантийном обслуживании.
При ремонте или гарантийном обслуживании использовать только запасные части марки Legrand.

ارشادات الامان: (AR)

يجب تركيب هذا المنتج طبقاً للقواعد التركيب ويفضل أن يقوم بالتركيب كهربائيً مؤهل. فقد يؤدي التركيب والاستخدام غير الصحيح إلى مخاطر التعرض لصدمة كهربائية أو نشوب حريق. اقرأ التعليمات قبل التركيب وأخذ مكان التركيب المنتج في الاعتبار. لا تفتح أو تفكك أو تعدل أو تحور المنتج ما لم يشر إلى ذلك بشكل محدد في التعليمات. فكل منتجات Legrand يجب فتحها وإصلاحها بواسطة مدربين ومؤهلين لدى Legrand. وكل فتح أو إصلاح غير مسموح به يبطل المسؤوليات وحقوق الاستبدال والضمانات. لا تستخدم سوى إكسسوارات من ماركة Legrand حصراً.

Approval conveyed herein neither relieves Vendor/Contractor of his contractual obligations and his responsibilities for correctness of materials, components & accessories of Implementation, quantities, design details assembly fits system/ performance requirement and conformity of supplies with Indian Statutory Laws as may be applicable, nor does it limit the purchaser's under the Contract/RFP requirements.

PoE Switch + 4 Combo Ports

DG-GS1512HP APPROVED

Key Features:-

- Supports up to 8 10/100/1000Mbps Gigabit Ethernet PoE ports and 4 SFP slots
- IEEE 802.3af/at PoE compliant to simplify deployment and installation
- Supports PoE up to 30W per port with 140W total power budget
- IEEE 802.1Q VLAN, Access Control List (ACL)
- Switch capacity: DG-GS1512HP: 24Gbps, Forwarding rate: 41.6Mpps
- Supports IGMP Snooping V1 / V2 / V3
- 8K MAC address table and 10K jumbo frames
- 19-inch rack-mountable metal case

Introduction:-

DIGISOL DG-GS1512HP is a Web Managed switching product. It is an intelligent network manageable switch designed for network environments that require high performance, high port density and easy for installation. It provides 8 Gigabit Ethernet PoE ports and 4 Giga combo ports. It supports VLAN, Port Mirroring and Port Trunking.

Performance and Scalability
It's a great L2 Web managed switch with 24 Gbps switching capacity. Wire-speed switching performance helps to take full advantage of existing high performance on PCs and laptops by significantly improving the responsiveness of applications and file transfer times. The device also has Four Gigabit SFP ports for high speed uplinks to servers or backbones.

Continuous Availability
IEEE 802.1w Rapid Spanning Tree Protocol provides a loopfree network and redundant links to the core network with rapid convergence, to ensure faster recovery from failed links, enhancing overall network stability and reliability. IEEE802.3ad Link Aggregation Control Protocol (LACP) increases bandwidth by automatically aggregating several physical links together as a logical trunk and providing load balancing and fault tolerance for uplink connections.

Comprehensive QoS
Traffic is prioritized according to 802.1p giving optimal performance to real time applications such as voice and video.

Enhanced Security
Port Security ensures access to switch ports based on MAC address. Thus limiting the total number of devices from using a switch port and protects against MAC flooding attacks.

Simplified Management
User friendly web interface facilitates ease of management. It also supports to be managed and controlled by network station.

DIGISOL™

SWITCHING SOLUTIONS

Technical Specifications:-

Physical Port
- 8 10/100/1000 Base-T Ethernet PoE Ports
- 4 Gigabit Combo (RJ-45/SFP) Ports
- Reset Button: reset to default setting, re-start system

Performance
- Switching Capability: 24Gbps
- MAC Address Table: 8K
- PoE Power Budget: 140W
- Packet buffer size: 4.1MB
- Jumbo Frame: 10K

L2 Features
- Auto-negotiation for port speed and duplex mode
- Spanning Tree Protocol
  - Support STP / RSTP / MSTP (max 16 instance)
  - Loopback Detection
  - BPDU Filter
  - BPDU Guard
- LLDP
- IGMP v2/v3 Snooping: IGMP Querier, Immediate Leave
- MVR
- VLANs
  - 256 IEEE 802.1q tag based VLAN with 4K VLAN ID
  - MAC Based VLAN, Voice VLAN, Guest VLAN, Management VLAN
- Link Aggregation
  - LACP: 8 Groups, 8 Ports/Group
  - Static Trunk

QoS Features
- Queueing Mechanism: SP and WRR
- Classifications based on
  - COS, COS DSCP, IP Precendence
- Each port supports 8 queues
- Rate Limit (Port Based): Ingress/ Egress Port
- Flow Control

Security
- MAC address Binding
- Support Broadcast/Multicast/Unicast storm control
- IP and MAC ACL (Ipv4)
- RADIUS, 802.1x based Authentication
- Port Security, Protected Port
- DOS • Management ACL
- DHCP Snooping, DHCP Snooping option 82, IP Source Guard, IP-MAC-Port-VLAN Binding

Management
- Port Mirroring
- Support traffic statistics
- Provide IPv4 Web-based management
- IPv4 DHCP Client
- Configuration Backup and Recovery
- Dual firmware images and Configuration files
- Error Disabled, Bandwidth Utilization
- SNMP v1/v2c/v3 • Remote Server
- Telnet, SSH,HTTP, HHTPS
- RMON, SNTP
- Ping, Traceroute
- EEE, Port Statistics

Power Supply
- AC Power: 100 to 240 V, 50-60 Hz
- Input Surge Protector
- PoE: 140W

Standards
- IEEE 802.3 10BASE-T
- IEEE 802.3u 100BASE-TX
- IEEE 802.3ab 1000BASE-T
- IEEE 802.3az IEEE
- IEEE 802.3at & IEEE 802.3af

Environmental Specifications
- Temperature : Operating: 0°C ~ 40°C Storage: -40°C ~ 70°C
- Humidity: Operating: 10% ~ 90% RH (Non-condensing) Storage: 5% ~ 90% RH (Non-condensing)

Mechanical
- Dimensions (WxDxH): 330mm x 230mm x 44mm
- LED Indicators: Power, Link/Act
- Hardware Factory Reset button

Warranty
- DIGICARE Limited Lifetime Warranty

Optional Accessories:-

DG-SA1030: DIGISOL 1000Base-SX SFP Transceiver LC Type
DG-SA1133: DIGISOL 1000Base-LX SFP Transceiver LC Type

Ordering Information:-

DG-GS1512HP: DIGISOL 8 10/100/1000Mbps Web Managed Gigabit Ethernet PoE Switch + 4 Combo Ports

*Limited Lifetime Warranty shall be subject to terms and conditions specified in the DIGISOL PRODUCT WARRANTY displayed on the website of the company.

DIGISOL is a Subsidiary of Smartlink Holdings Limited

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MORLEY IAS
FIRE SYSTEMS

Addressable Relay Module

APPROVED

HM-D240CMO-UL

UL LISTED

General

The HM-D240CMO-UL Addressable Relay Module provides the system with a dry contact output for activating a variety of auxilary devices, such as fans, door holders, dampers, control equipment, etc. Addressability allows the dry contact to be activated through panel programming, on a select basis.

HM-D240CMO-UL

Applications

The HM-D240CMO-UL may be programmed to operate dry contacts for door holders, Air Handling Unit shutdown, etc., and to reset four-wire smoke detector power.

Construction

- The face plate is made of off-white, heat resistant plastic
- Controls include two rotary switches for direct-dial entry of address-setting
- The HM-D240CMO-UL is configured for a single Class B Notification Appliance Circuit
- The HM-D240CMO-UL provides two Form-C dry contacts that switch together

Operation

Each HM-D240CMO-UL uses one of the addresses on a SLC loop. It responds to regular polls from the control panel and reports its type and status. The LED blinks with each poll received. On command, it activates its internal relay.

NOTE: Open/short supervision is suspended with the HM-D240CMO-UL.

Rotary switches set a unique address for each module. The address may be set before or after mounting. The built-in TYPE CODE (not settable) will identify the module to the control panel, so as to differentiate between a control module and a relay module.

FEATURES & BENEFITS

- Built-in type identification automatically identifies these devices to the control panel
- Internal circuitry and relay powered directly by two-wire SLC loop
- Integral LED “blinks” green each time a communication is received from the control panel and turns on in steady red when activated
- High noise immunity (EMF/RFI)
- Wide viewing angle of LED
- SEMS screws with clamping plates for wiring ease
- Direct-dial entry of address: 61 -99 for models SMX and STX

HM-D240CMO-UL Technical Specifications

PARAMETER	SPECIFICATION
Normal operating voltage	15 to 32 VDC
Maximum SLC current draw	6.5 mA (LED on)
Average operating current	230 µA direct poll (CLIP mode) with LED flashing
EOL resistance	Not Used.
Temperature range	32°F to 120°F (0°C to 49°C)
Humidity range	10% to 93% non-condensing
Dimensions	4.5" (11.43 cm) high x 4" (10.16 cm) wide x 1.25" (3.175 cm) deep. Mounts to a 4" (10.16 cm) square x 2.215" (5.398 cm) deep box

Relay Contact Ratings

- **Load Descripton:** Resistive
- **Application:** Non-Coded
- **Maximum Voltage:** 30 VDC
- **Current Rating:** 3.0 A

Agency Listings and Approvals

Listing and approval below apply to the modules specified in this. In some cases, certain modules may not be listed by certain approval agencies, or listing may be in process. Consult factory for latest listing status.

- **UL**: S35595

Product Line Information

HM-D240CMO-UL	Intelligent addressable relay module
SMB500	Optional surface-mount backbox
CB500	Optional control module barrier, required by UL for separating power-limited and non-power-limited wiring in the same junction box as HM-D240CMO-UL

NOTE: For installation instructions, see document CN-MN-0195 and refer to the SLC Wiring Manual.

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Approval conveyed herein neither relieves Vendor/Contractor of his contractual obligations and his responsibilities for correctness of materials, components & accessories of Implementation, quantities, design details assembly fits system/ performance requirement and conformity of supplies with Indian Statutory Laws as may be applicable, nor does it limit the purchaser's under the Contract/RFP requirements.

Multiple detectors can be connected to a single RI, but for individual Fire Detector alarm identification it is recommended to connect single detector with a single RI.

- Rugged / Industrial Design
- Flush Mounting, Wall mounting
- High bright LED (Wide Viewing Angle)
- Operating voltage - 5 to 28V DC
- Current - >15mA @ 12V DC
- Life upto 100000 Hrs.

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Honeywell | Annunciator

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315-080

80-Character Serial LCD Annunciator

UL-LISTED

General

The 315-080 annunciator is a compact, backlit, 80-character LCD fire annunciator that mimics the Fire Alarm Control Panel (FACP) display. It provides system status indicators for AC Power, Alarm, Trouble, Supervisory, and Alarm Silenced conditions. The 315-080 and the FACP communicate over a two-wire serial interface employing the Repeater-Bus communication format. Connected devices are powered, via two additional wires, by either the host FACP or a remote UL-listed, filtered power supply.

The 315-080 displays English-language text of system point informa-tion including device type, zone, independent point alarm, trouble or supervisory status, as well as any custom alpha labels programmed into the control panel. It includes control switches for remote control of critical system functions. (A keyswitch prevents unauthorized operation of the control switches.)

Up to eight 315-080 repeaters may be connected to the Repeater-Bus of each FACP. No programming is required, which saves time during system commissioning.

Controls and Indicators

- AC Power
- Alarm
- Supervisory
- Alarm Silenced
- Trouble

KEY FEATURES

- Listed to UL Standard 864, 9th Edition
- Backlit 80-character LCD display (20 characters x 4 lines)
- Mimics all display information from the host panel
- Control switches for System Acknowledge, Signal Silence, and Reset
- Control switches can be independently enabled or disabled at the FACP
- Keyswitch enables/disables control switches and mechanically locks annunciator enclosure
- Keyswitch can be enabled or disabled at the FACP
- Enclosure supervised for tamper
- System status LEDs for AC Power, Alarm, Trouble, Supervisory, and Alarm Silence
- Local sounder can be enabled or disabled at the FACP
- 315-080 connects to the Repeater-Bus terminal on the FACP and requires minimal panel programming
- Displays device type identifiers, individual point alarm, trouble, supervisory, zone, and custom alpha labels
- Time and date display field
- Surface mount directly to wall or to single, double, or 4” square electrical box
- Semi-flush mount to single, double, or 4” square electrical box. Use ANN-SB80KIT for angled view mounting
- Can be remotely located up to 6,000 feet (1,800 m) from the panel
- Backlight turns off during AC loss to conserve battery power but will turn back on if an alarm condition occurs
- May be powered by 24 VDC from the host FACP or by remote power supply (requires 24 VDC)
- Up to eight 315-080 repeaters can be connected on the RS485 Repeater-Bus

315-080 Technical Specifications

Operating voltage range	18 VDC to 28 VDC
Current consumption	@ 24 VDC nominal (filtered and non resettable): 40 mA maximum
Ambient temperature	32°F to 120°F (0°C to 49°C)
Relative humidity	93% ± 2% RH (non-condensing) at 32°C ± 2°C (90°F ± 3°F)
Dimention	5.375" (13.65 cm.) high x 6.875" (17.46 cm.) wide x 1.375" (3.49 cm.) deep
For use	Indoors in a dry location
Connections	All connections are power-limited and supervised

The Repeater-Bus:

- **Powering the devices on the Repeater-Bus from auxiliary power supply**
  The Repeater-Bus can be powered by an auxiliary power supply when the maximum number of Repeater-Bus devices exceeds the Repeater-Bus power requirements. See the FACP manual for more information.
- **Repeater-Bus Device Addressing**
  Each Repeater-Bus device requires a unique address (ID Number) in order to communicate with the FACP. A maximum of 8 devices can be connected to the FACP Repeater-Bus communication circuit. See the FACP manual for more information.
- **Wire Requirements: Communications Circuit**
  The 315-080 connects to the FACP Repeater-Bus communications cir-cuit. To determine the type of wire and the maximum wiring distance that can be used with FACP Repeater-Bus accessory modules, it is necessary to calculate the total worst case current draw for all modules on a single 4-conductor bus. The total worst case current draw is calculated by adding the individual worst case currents for each module.

  NOTE: For total worst case current draw on a single Repeater-Bus refer to appropriate FACP manual.

- **Wire Requirements: Power Circuit**
  - 14 to 18 AWG (0.75 - 2.08 mm2) wire for 24 VDC power circuit is acceptable. Power wire distance limitation is set by 1.2 volt maximum line drop form source to end of circuit.
  - All connections are power-limited and supervised.
  - A maximum of eight 315-080 repeater modules may be connected to this circuit.

Agency Listings and Approvals

The listings and approvals below apply to the 315-040. In some cases, certain modules may not be listed by certain approval agen-cies, or listing may be in process. Consult factory for latest listing status.

- **UL Listed:** S36108

Ordering Options

- **315-080:** Red 80 character LCD Annunciator

For more information
www.morley-ias.co.uk

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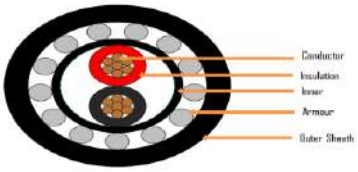
REACH & RoHS ✓

RR KĀBEL LTD

Part No	Item Code For RR Kabel , Waghodia reference only		FCA72SWL1X502BK (Item code subjected to availibility)

GURANTEED TECHNICAL PARTICULAR

Cable Type:- ***Copper Class 2 Conductor, XLPE Insulated, PVC ST 2 Inner Sheathed & PVC ST 2 FR-LSH Sheathed ARM cable as per IS:7098 P-1***



Drawing is for representation purpose only & not to scale.

APPROVED

Dipika Parmar Revision: 00 Valid from: june 2018

	CABLE SIZE :		2C X 1.5 mm²
	PARAMETER	**UOM**	**SPECIFICATION**
A.	**General Particulars**		
1	Make & Country	-	RR KABEL, INDIA
2	Type	-	2XWY
3	Voltage Grade	kV	1.1 / 1.5 (A.C / D.C)
4	Standard drum length with tolerance	mtr	1000 (± 5%)
5	Recommended minimum bending radius	mm	Cable diameter X 15
6	Maximum Safe pulling force when pulled by pulling eye	Kg/mm^2	5 kg/sq.mm of Copper area
7	Maximum Safe pulling force when pulled by stocking # Refer foot note	Kg/mm^2	5 kg/sq.mm of Copper area
8	Approx Overall Diameter (± 2mm)	mm	12.50
9	Suitable for	--	Earthed & Un-earthed system
10	Packing material	--	Wooden drum
B.	**Design & construction**		
1	**Conductor**		
a	Material	-	Annealed Copper Conductor
b	Type of Conductor	-	Class-2, Stranded Round Conductor as per IS 8130
c	Number of wire	Nos	7
d	Maximum conductor temperature for cont. use	° C	90
e	Maximum conductor temperature allowed for short circuit condition	° C	250
2	**Insulation over Conductor**		
a	Material	-	XLPE
b	Type	-	As per IS:7098 (P-1) Specification
c	Thickness nominal	mm	0.70
d	Color of core for identification	-	RED, BLACK
e	Volume Resistivity test		
1	@ 27 °C	Ω-cm	$1 X 10^{14}$ min
2	@ 90 °C	Ω-cm	$1 X 10^{12}$ min
f	Before Aging test		
1	Tensile Strength	N / mm^2	12.5 minimum
2	Elongation at break	%	200 minimum
3	**Lay - up**		
a	Lay Direction		Right Hand Direction
4	**Inner Sheath**		
a	Material		Extruded PVC ST2 as per IS:7098 PT-1 , (IS:5831)
b	Thickness Min	mm	0.30
c	Color of sheath		Black
5	**Armouring**		
a	Armouring Material		G.I. Wire
b	Lay direction of Armouring		Left Hand Direction
c	Dimension of Wire/Strip	mm	1.40 (± 0.04mm Tolerance)
6	**Outer Sheath**		
a	Extruded Material		PVC ST2 FR-LSH Compound as per IS:5831
b	Thickness	mm	1.24 Minimum
c	Color of sheath		Black
d	Before Aging test		
1	Tensile Strength	N / mm^2	12.5 minimum
2	Elongation at break	%	150 minimum
7	**Flammability Test**		
a	Length of undecomposed portion from top clamp	mm	50 minimum
b	Period of burning after removal of flame	sec.	60 maximum
8	**Printing Message**		
a	**RR KABEL 2C X 1.5 SQ.MM 1100V 2XWY FRLS ELECTRIC CABLE IS 7098 P-1 CM/L 3781574 ISI +0001m**		
9	**Electrical Properties**		
a	High Voltage Test		3kV for 5 minutes
b	Current Carrying Capacity		
1	In Ground @ 30°C	Amps.	33.00
2	In Duct @ 30°C	Amps.	25.00
3	In Air @ 40°C	Amps.	29.00
c	Approx Capacitance	µF/KM	0.0000
d	Approx Reactance at 50 Hz	Ω/Km	0.1070
e	Short Circuit Rating for 1 Sec	K.Amps	0.2100
f	Maximum conductor resistance at 20° C (D.C)	Ω/Km	12.1000
g	Maximum conductor resistance at 90° C (A.C)	Ω/Km	15.2000
h	Permissible Voltage Variation	%	± 10
i	Permissible Frequency Variation	%	± 5
j	Combined Voltage & Frequency variation	%	± 10
C.	**Additional test if any applicable**		
	FR-LSH Test on Outer Sheath		
a	LOI as per ASTM D2863 and IS 10810 part-58	%	29 minimum
b	LTI as per ASTM D2863 and IS 10810 part-64	°C	250 minimum
c	HCL Acid gas evaluation test as per IEC-754-1,IS 10810 Part-59	%	20 maximum
d	Smoke Density Test as per IS 13360 Part 6/Section 9	%	60 maximum

This is electronically generated sheet no signature is required

Note:1 When using a stocking the same value apply but a stocking with correct diameter and length should be selected,such that all the tension is transferred to conductor this is evident when there in no relative moment between the extruded layers and conductor at pulling end.

Note:2 Diameter mentioned in the datasheet is for reference purpose only,there is no specific diameter requirement in standard.

Approval conveyed herein neither relieves Vendor/Contractor of his contractual obligations and his responsibilities for correctness of materials, components & accessories of Implementation, quantities, design details assembly fits system/ performance requirement and conformity of supplies with Indian Statutory Laws as may be applicable, nor does it limit the purchaser's under the Contract/RFP requirements.

Ceiling Mount Access Point

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DG-WM6305SIE2

LIMITED LIFETIME WARRANTY

Key Features:-

- IEEE 802.11n 2.4GHz/ 802.11ac 5GHz Wireless
- WAN/PoE: 1x 10/100/1000Mbps 802.3at/af PoE Port
- LAN: 1x 10/100/1000Mbps
- Multiple SSID: Up to 8 SSIDs
- IEEE 802.1q Tag based VLAN
- QoS-WMM Support
- Multiple Operational Modes

Introduction:-

DIGISOL Wireless AP DG-WM6305SIE2 enables communication between wireless and wired notebooks/desktop computers in the network. It complies with IEEE 802.11ac standard and is backward compatible with IEEE 802.11b/g/n standard. The DG-WM6305SIE2 wireless AP support MIMO (Multiple-Input Multiple-Output) and 4 Spatial Steams, greatly to improve the communication efficiency, with combined 1200Mbps Wi-Fi speed over 2.4GHz(300Mbps) and 5GHz(900Mbps), equipped with Gigabit WAN & LAN port which enhances the sharing of files, photo, audio, video and gaming experience over wireless network, the device can also be used as router when configured in gateway mode. DG-WM6305SIE2 supports PoE, which helps in easy installation by eliminating the need of a dedicated power source.

DIGISOL™

WIRELESS AND BROADBAND

Technical Specifications:-

Hardware Specifications
- WAN/PoE: 1x 10/100/1000Mbps 802.3at/af PoE Port
  LAN: 1x 10/100/1000Mbps
- Antenna: 5dBi
- Design: Ceiling Mount

Standards Compliance
- IEEE 802.3 10BASE-T Ethernet
- IEEE 802.3u 100BASE-TX Fast Ethernet
- IEEE 802.3ab 1000BASE-T Gigabit Ethernet
- IEEE 802.3at/af PoE
- IEEE 802.11b/g/n/ac

WLAN Data Transfer Rates
- IEEE 802.11b up to 11Mbps
- IEEE 802.11g up to 54Mbps
- IEEE 802.11n up to 300Mbps
- IEEE 802.11ac up to 900Mbps

Wireless Functions
- 802.1q Tag based VLAN Support
- Wifi Operational Modes
  - AP Only Mode
  - Universal Repeater Mode
  - WISP Mode*
  - Gateway Mode*
  - DHCP/ Static/ PPPoE*
- Multiple SSID Support (Upto 4 SSIDs per frequency band)
- Wireless Security
  - WEP
  - WPA
  - WPA-PSK
  - WPA2
  - WPA2-PSK

Advanced Features
- Firewall
  - MAC Access Control
  - IP/MAC/URL Filtering*
  - Port Forwarding*
  - DMZ*
- DHCP Server*
- Management
  - UPnP*

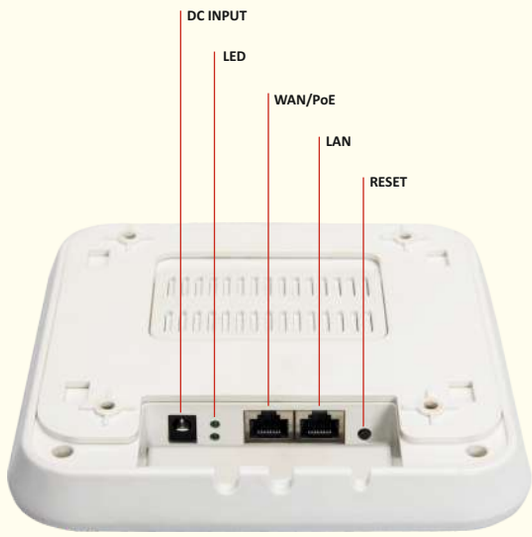
Management
- Web based management
- Backup & Restore Settings

Wi-Fi Transmit Power
- Up to 27dBm

Power
- PoE OR DC 12V/1A

Warranty
DIGICARE Limited Lifetime warranty

IEEE 802.11ac | PoE | Multiple SSID



Ordering Information:-

DG-WM6305SIE2: DIGISOL 802.11ac 1200Mbps Ceiling Mount Access Point with 10/100/1000Mbps PoE Port

**Limited Lifetime Warranty shall be subject to terms and conditions specified in the DIGISOL PRODUCT WARRANTY displayed on the website of the company.

*Supported only when configured in WISP/Gateway mode.

DIGISOL is a Subsidiary of Smartlink Holdings Limited

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HN-CL06/ 6W CEILING LOUDSPEAKER

- Flush-mounting system for fast and easy installation
- Wide frequency response for excellent speech and music reproduction
- Excellent crash and rust resistant design
- Fully ABS plastic with metal grille
- Power tapping options available -6/3/1.5W

PRODUCT DESCRIPTION

HN-CL06 is an all-purpose 6W ceiling speaker with an excellent audio performance and aesthetic appealing enclosure. This speaker features a high sound pressure level and a wide frequency response and low distortion for high sound level suitable for speech and music reproduction.

HN-CL06 has two spring clamps which can be used to easily fix the speaker into the false ceiling. It has three power taps (6/3/1.5W) with the built in 100V transformer. The round metal grille is well fitted in the front.

Technical Specification	
Rated Power / Max Power	6W / 9W
Power Taps	6w / 3w / 1.5w
Rated Voltage	100 V
Sound Pressure Level at 1w (1m& 1kHz)	90 ± 5 dB
Rated Impedance	1667Ω / 3333Ω / 6666Ω
Frequency Response	125Hz – 16kHz (-10 dB with reference to 1kHz)
SPL at rated power/1W	95dB / 88dB (1m & 1kHz)
Size of Speaker (dia)	166 mm
Hole cut out	140 mm
Magnet Weight	90 gm
Connection	4 Pole screw connector
Dimension	166mm X 60mm
Color	White
Weight of Speaker	500 gm

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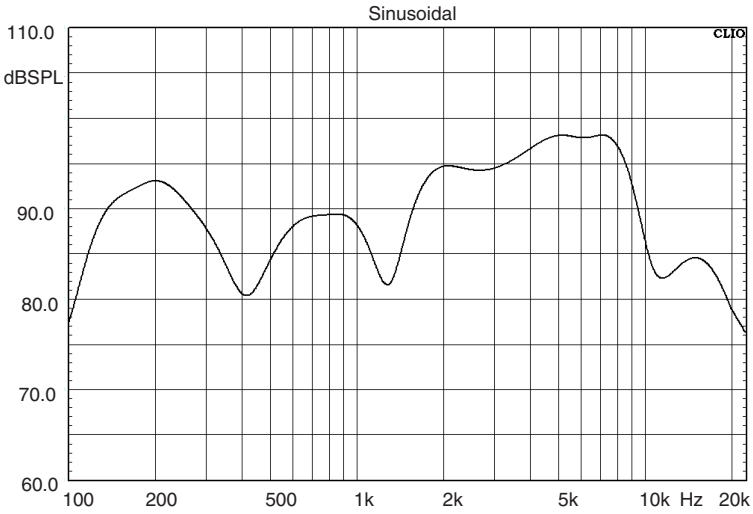
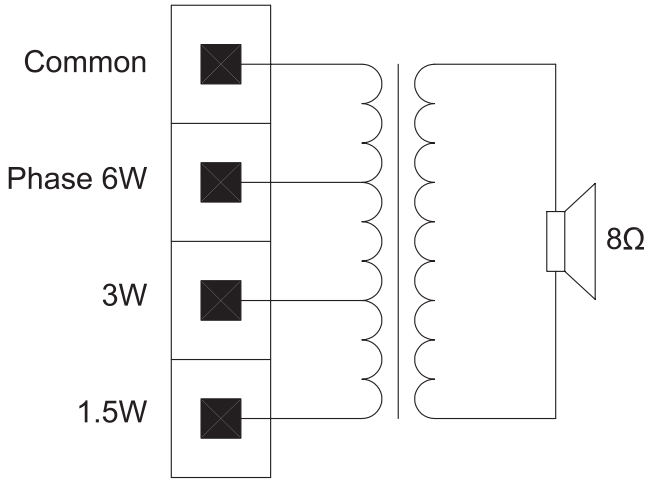
Frequency Response:



Circuit Diagram:



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HN-CL06
6W CEILING LOUDSPEAKER

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THE POWER OF CONNECTED | X-618 MEGA Public Address

X-DA1500EN

High Efficiency Power Amplifier with 24 VDC Backup Power Supply

X-DA1500EN is the Class-D amplifier and it is lighter, more stable, and high efficiency. The audio transmission is completely digitalized which makes it free from interference and easy to be controlled. It also has 24 VDC backup power supply conforming to international voice alarm standard which is the perfect choice for safety required applications.

When a shout circuit is detected in the main power supply circuit, the power will be automatically shut down.The backup power supply will then be enabled to replace the main one.

When a fault, self-protection or self-testing happens, its audio input fault port on the rear panel will short circuit and a fault signal will then be sent to the control unit in the network.

X-DA1500EN

Features

Input/Output

X-DA1500EN supports both balanced and unbalanced audio inputs.To receive unbalanced audio inputs, simply connect the ground port with the negative input port to the rear panel.

X-DA1500EN can receive audio signal from X-DCS3000 via Ethernet through the RJ45 standard port.

Fault Detection

X-DA1500EN can self-protect from overheat, over current, over voltage and under voltage. For example, when the internal temperature reaches its critical limit, the overheat protection circuit will shut down the power amplification module and activate the protection indicator light on the front panel.

X-DA1500EN can detect power supply errors automatically during operation.The built-in fuse will provide over current protection to the main power supply.

Safety

The device adopts lightweight design. The front panel is made of UL94V-0 fire proof ABS material, protecting the machine under extreme conditions.

A cooling fan is equipped for heat exhaustion so that the machine can maintain high working efficiency. The amplifier can work without main power in emergency.

Volume Control

When X-ND100 Noise Detector is installed, X-DA1500EN can support X-DCS3000 to realize auto volume control function based on ambient noise level change.

Indicators

- Power light
- AC fault light
- DC fault light
- Signal light (for each channel)
- Clip light (for each channel)
- Protection light (for each channel)

Interfaces

- Main power and 24 VDC backup power port
- Audio inputs (balanced or unbalanced)
- Audio outputs (100V or 70V)
- RJ-45 net cable port

FEATURES AND BENEFITS

- One-channel 500W efficiency Class-D amplifier
- Automatic protection
- With 24 VDC backup power supply
- Fault detection
- Effective ventilation using forced air cooling fan
- UL 60065, FCC compliant

X-DA1500EN

TECHNICAL SPECIFICATIONS

PARAMETERS	VALUES
Rated Power	1 × 500 W
Main Power Supply Voltage	~ 100 - 240 V, 50/60 Hz
DC Backup Power Supply Operating Voltage Range	21.5 V - 28.5 V DC
Power Consumption	< 700 W
Main Power Supply Protection	T10 AL 250 V
Speaker Output Voltage	100 V / 70 V
Frequency Response	70 Hz -18 kHz(+1 dB ~ -3 dB)
Input Sensitivity	1.414 V_{RMS}
Impedance	20 kΩ
SNR	> 100 dB(withA- Weight)
Non-linear Distortion	< 0.05 % (at 1/3 rated power, 1 kHz)
Indicators	Power indicator light Main power fault light Backup power fault light Signal lights Peak clipping lights Equipment protection lights
Number Of Channels	1
Operating Conditions	95 % humidity, 0 °C ~ +40 °C (0 ~ 104 °F) (no condensation)
Storage Temperature	-10 °C ~ +55 °C (14°F ~ 131°F)
Cooling Method	Air cooling
Product Dimensions (W×H×D)	482 × 88 × 420 mm (18.98 x 3.46 x 16.54 in.)
Package Dimensions (W×H×D)	580 × 235 × 552 mm (22.83 x 9.25 x 21.73 in.)
Net Weight	10.8 kg (23.81lbs.)
Gross Weight	13.9 kg (30.64lbs.)

Note: Honeywell reserves the right, without notification, to make changes in product design and/or specifications.

PACKING LIST

COMPONENT	QUANTITY
X-DA1500EN High Efficiency Power 1 Amplifier	1
Network Cable	2
Input Cable Terminal	2
Output Cableterminal	2
AC Power Cable	1
Power Connector Kit	2
Warranty Card	1
Quality Certificate	1
Product Manual	1

CERTIFICATION AND STANDARD

CATEGORY	REGION	CERTIFICATION
Safety	Europe	CE Complied
Safety	Global	CB Certified
Safety	USA	UL60065 Certified

ORDERING INFORMATION

ORDERING INFORMATION	DESCRIPTION
X-DA1500EN	X-DA1500EN High Efficiency Power Amplifier 1×500W with 24 VDC backup power supply

Honeywell
12 Clintonville Road
Northford, CT 06472, USA
Hwll.co/Notification

HBT-G.C.-X-DA1500EN-Oct.2018-EN01

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THE POWER OF CONNECTED

X-618 MEGA Public Address

X-NPMS

Configurable IP Call Station

The X-NPMS connects to the X-618 system, transmitting audio and control signal through the Ethernet. It is used for live paging, audio task delivery , audio monitoring zones , and inter-communication.

X-NPMS

Features

FUNCTIONS

- Manual emergency broadcast
- Normal broadcast control
- Zoning and grouping broadcast
- Monitoring function
- Internal communication
- Faults monitoring
- Automatic record
- Quick and simple broadcast
- Recording audio in advance and broadcasting
- Broadcasting the audio file of U-disk
- Daily record

INDICATORS

POWER indicator: Show power supply status, green means normal .

RUNNING indicator: Show devices working status, flashing green means normal.

FAULT indicator: Show faults of system.
If there is a fault, the indicator will be flashing yellow. And when the fault is confirmed, it keeps lighting yellow.
The indicator will be off when the system is normal.

NETWORK indicator: Show network status. Yellow means network connection failure. Flashing yellow means network has been connected but the station can't communicate with other device.
Green means normal.

MIC WORKING STATUS indicator: show the working status of microphone. Yellow means a fault of microphone. Flashing green means broadcasting warning tone.
Green means microphone is working.
The indicator is off when microphone is normal and not working.

TOUCH SCREEN

Users can operate directly on the innovative 7-inch color LCD touch screen without adding an extra key module unit.With the touch screen, users can supervise the system status, select broadcast zones, assign zone groups or other broadcast controls, including setting playlists, timing broadcastings etc. With the built-in configuration software, zones broadcast status or button functions can be configured easily.

SHORT-CUT OPERATION

X-NPMS has virtual keys in the user interface and extension keypad which are all programable as short-cut keys of task to process audio delivery, live paging, zoning and grouping. The emergency bro- adcast button can switch the system to emergency broadcast mode, where the recorded evacuation message will be played and fire alarm will be activated without delay.

FEATURES AND BENEFITS

- Easy touch screen operation with 7" TFT LCD screen and simple user interface.
- Optional gooseneck microphone or PTT microphone.
- Built-in loudspeaker for zone audit and talk- back communication function.
- Configurable keys for audio task delivery, zoning and grouping.

X-NPMS

Features

CONNECTIONS

X-618 system can connect with up to 250 X-NPMS via Ethernet. X-NPMS can be used as a node anywhere in the network. To reduce wiring cost, the devices can be connected into an existing network provided that there is sufficient band width to reduce wiring cost.

AUDIO TRANSMISSION

The device comes with a detachable gooseneck microphone. Users can change different types of microphone for different real-time broadcasting requirements. The received audio signal will be digitalized to eliminate sound distortion during transmission.
The built-in speaker not only can be used for zone monitoring but also full-duplex intercom with other X-NPMS in the network.
X-NPMS supports fail-safe operation. Even when the connected X-DCS3000 fails, X-NPMS is still able to communicate with other X-NPMS and broadcast through other X-DCS3000 in th network.

TECHNICAL SPECIFICATIONS

PARAMETERS	VALUES
Power Supply Voltage	DC 24V
Rated Power	11W
MIC Frequency Response	50Hz~15kHz
SNR	›85dB
THD	‹0.05%
Microphone Input	-44dB±2dB
Monitoring Loudspeaker	2 W / 8Ω
Line Input	0dBV(1V)
Line Output	0dBV(1V)
LCD Size	7 Inch
LCD Resolution	800x480
Sampling Rate	44.1 KHz, 16 Bit
Operating Temperature	-10 °C~+ 55 °C
Storage Temperature	-40 °C~+ 70 °C
Relative Humidity	‹95%, without condensation
Net Weight	1.7 Kg
Gross Weight	2.5 Kg
Dimension	200x200x46.5mm

Note: *Honeywell reserves the right, without notification, to make changes in product design and/or specifications.*

ORDERING INFORMATION

ORDERING INFORMATION	DESCRIPTION
X-NPMS	X-NPMS Configurable Network Paging Station

Honeywell
12 Clintonville Road
Northford, CT 06472, USA
Hwll.co/Notification

HBT-G.C.-X-NPMS-Oct.2018-EN01

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L-PBM20A
Bidirectional Projection Loudspeaker

FEATURES

- Intelligible voice and superior sound reproduction
- Ceiling or wall mount installation
- Meets virtually any indoor and outdoor requirement
- Complies with IP65 standard
- Complies with international safety laws

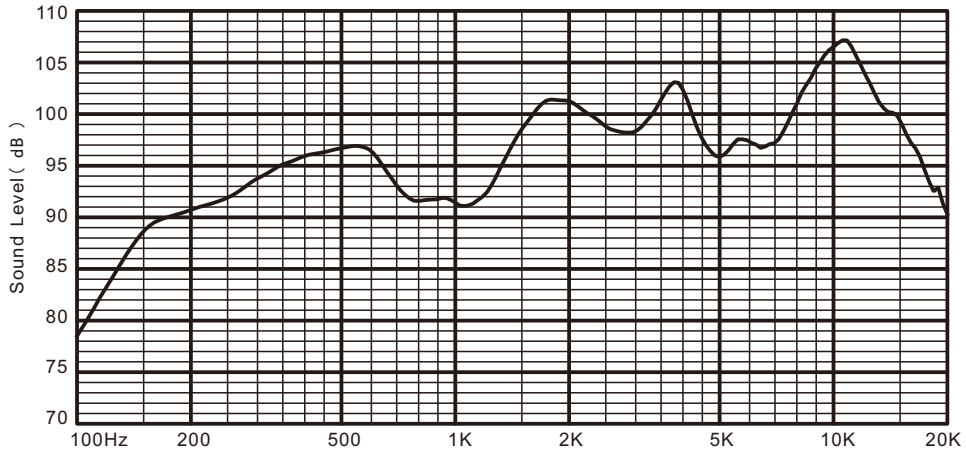
PRODUCT DESCRIPTION

L-PBM20A is a high-performance 20 W public address bidirectional projection loudspeaker. It provides a broad frequency response range, low distortion and high sound pressure level for accurate and intelligible broadcast of evacuation messages and high quality sound reproduction. It can be used in indoor, outdoor, dry, or wet applications, providing reliable operations over wide temperature and humidity ranges. Bidirectional projection loudspeaker is the best choice for applications such as tunnel, gallery and shopping arcade.
In case of a fire emergency, its aluminum enclosure and high-temperature ceramic wiring connector protect the speaker's internal components from the increased heat often present in fire conditions, extending its ability to remain operational and broadcast important information during a fire emergency. In addition, the loudspeaker's front cover and bracket are also made of aluminum, making them durable and corrosion proof. The loudspeaker is also supplied with a temperature fuse that protects it from overheating due to improper loading.

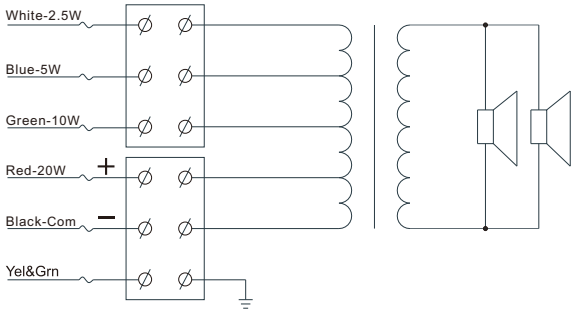
TECHNICAL SPECIFICATIONS

Model	**L-PBM20A**
Max power	30 W
Rated power	20 W (10 W × 2)
Power taps @ 100V	20 W / 10 W / 5 W / 2.5 W
SPL at 20 W / 1 W (4 KHz , 1m)	104 dB / 92 dB
Frequency response(-10 dB)	150 Hz -15 KHz
Dispersion angle(1 KHz / -6 dB)	180°
Rated input voltage	100 V / 70 V
Rated impedance	500 Ω / 1 KΩ / 2 KΩ / 4 KΩ
Connector	Fire-resistant cable
Dimensions	Φ140 × 195 mm
Weight	3.23 Kg
Color	White(RAL9003)
Speaker size	5.25" × 2
Operating temperature	-25 ℃ to +55 ℃
Storage temperature	-40 ℃ to +70 ℃
Relative humidity	< 95 %

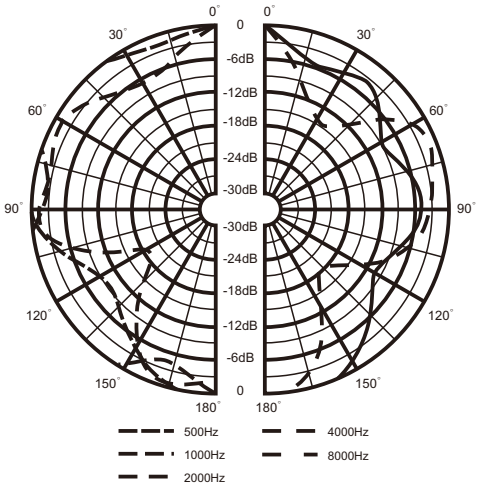
FREQUENCY RESPONSE



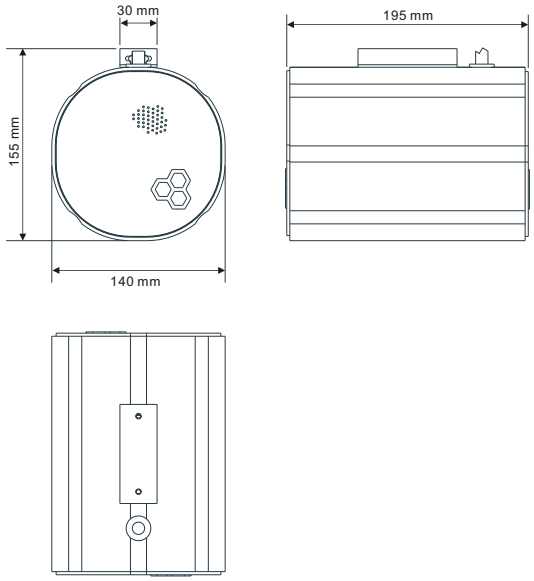
CIRCUIT DIAGRAM



POLAR DIAGRAM



THREE-VIEW DIAGRAM



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X-DCS2000/EN DIGITAL INTEGRATED SYSTEM MANAGER

- Highly integrated
- Easy-access preset buttons
- Built-in fault diagnosis
- Automatic volume control
- Extendable zones connections via software configuration

DESCRIPTION

X-DCS2000/EN Digital Integrated System Manager (abbr. DCS) is the basic unit of X-618 Public Address and Voice Alarm System. DCS integrates plentiful functions such as zone expansion, multiple audio sources support, audio file storage, net audio, broadcasting, zone control, monitoring, fault diagnosis etc. The supplied X-SMART management software allows users to easily and efficiently manage and control the system.

FEATURES

Input/ Output
DCS has 8 dry-contact outputs that can be used to activate external devices. It has 8 pairs of loudspeaker line output where each one allows multiple 100V loudspeakers to
be connected in parallel. A record output port is dedicated for external recording.

DCS also has 8 dry-contact inputs that can be linked with a fire alarm control center which supports broadcasting alarm tones and evac- uation announcement when fire happens. On the rear panel, there are 4 network audio input and 4 auxiliary inputs, which provide con- nections to external audio sources such as CD/DVD, cassette, FM tun- er etc. In addition, there are 4 audio inputs that are capable to adjust volume automatically according to ambient noise (when HN-D32N Noise Detector is installed). Users can set the phantom power and input gain of each volume control input on the rear panel.

Connections Expansion
DCS can connect with devices and the network to extend zone connections via 4 10M/100M adaptable Ethernet interfaces.

Safety and Robustness

DCS can detect errors on main power supply, backup power supply, amplifier circuit, amplifier protection, software, communications, and loudspeaker line in runtime. By locating the error's occurrence, DCS provides valuable information for repairing or replacing the malfunctioned devices.

DCS supports power supply and amplifier redundancy. Built-in fuse provides over-current protection to the main power supply. When a shortcircuit error is detected in DCS, the power supplied from main power will be cut off and switched to the backup one. Same technology is also used in amplifier switchover. User can configure the amplifier backup solution as 3 backup for 1 main, 2 backup for 1 main, 1 backup for 1 main or 2 backup for 2 main.

Audio Storage
DCS is built with a 1GB flash memory. Via X-618 Config software, users can upload audio files for later playback or audio synthesis. Volume controllers can be connect- ed with the DCS contact outputs to adjust the zones volume or force switching.

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Broadcasting
DCS supports a variable range of audio sources, such as audio files from external devices (CD/DVD, cassette, FM tuner and etc.), remote paging announcement or broadcasting from X-NPMI, announcements from the PTT emergency microphone etc.

DCS can broadcast 4 audio message or internet audio simultaneously. Timer broadcast setting can be configured via software to allow system to play specific programs at a specific time even when it is not supervised. With the software, user can also handle up to 255 priorities to meet complex public address requirements.

Zone Control
User can select audio sources and zones to broadcast by clicking directly on the control buttons on the front panel.

DCS supports audio matrix, allowing any audio sources to be played in any zones.

Monitoring
DCS has a built-in loudspeaker and it can enable zone and audio source monitoring. When the system has been extended via Ethernet, network remote supervision can be performed.

Shortcut Control

A highlight of DCS is the one-click emergency mode switchover feature. A red emergency mode button can be found on the front panel, which can activate the fire alarm broadcast mode in an emergency by a single click. In emergency mode, the recorded evacuation announcement will be broadcasted and the zone alarm indicator lights will be turned on. This function significantly improves the evacuation efficiency.

Users can preset the functions for the other buttons or their combo usage. The label describing buttons' functions can be replaced easily.

Components

Buttons for special operations: select all, reset, error confirm and etc.
Zone selection buttons
Audio source selection buttons
Emergency mode button

Certification and Standard

Category	Region	Certification
Safety	Europe	CE Complied
Voice Alarm	Europe	EN 54 (Part 16) Certified

Interfaces

8 dry-contact outputs
8 loudspeaker line outputs
8 dry-contact inputs
4 auxiliary audio inputs with AVC
4 noise detector inputs
4 amplifier interfaces
RS - 485 port for fire alarm
Main power port
Backup power port (DC 24V)
4 10/100M adaptable Ethernet interfaces

Indicator Lights

Device status indicator lights can show whether the device is powered, malfunctioned, disabled, running or delayed
Zone status indicator lights
Audio source status indicator lights

Ordering Information

Description	
X-DCS2000/EN Digital Integrated System Manager	X-DCS2000/EN
Push-to-Talk Microphone (accessory)	HN-PTT

Technical Specifications

Power Supply	
Main power supply	~100 - 240 V,50/60 Hz
Backup power supply	DC 21.5 V - 28.5 V
DC power output	DC24V/1A
Max. input power	120 W
Rated power	50 W
Audio Input	
Auxiliary input	1V(0dBV)
Input impedance	20 kΩ
Frequency response	60 Hz - 16 kHz
SNR	>85 dB
Audio Output	
Audio output channels	4
Output signal	1.2V(1.6dBV)
Record output	1V(0dBV)
AVC Input	
Channels	4
Input signal	14mV(-37dBV) or 330mV (-9.6dBV) configured by switch
Input impedance	20 kΩ
Phantom power	DC 24V, configured by switch
Frequency response	60 Hz - 16 kHz
SNR	>65 dB
Loudspeaker Circuit	
Output channels	8, with circuit fault detection function
Max. output load	500 W (If the line supervision is used, the load shall be less than 250W.)
Trigger Input / Output	
Trigger input ports	8
Trigger output ports	8 (NO, NC and COM)
Max. working voltage	AC 250 V / DC 30 V
Max. working current	2.5 A

Others	
Monitoring loudspeaker	10W / 8Ω
Ethernet speed	10 M / 100 M
Ethernet interface number	4
Storage space	1 GB
Work Condition	
Humidity	< 95 %, non condensing
Operating temperature	-10 °C ~ +55 °C
Storage temperature	-40 °C ~ +70 °C
Specification	
Dimension (W×H×D)	482 × 88× 420 mm
Mount dimension (W×H×D)	580 × 235 × 552 mm
Net weight	9.3 kg
Gross weight	12.5 kg

Parts included

Component	Quantity
X-DCS2000/EN	1
Panel paper	6
Dry-contact input connector (8P)	2
Dry-contact output connector (6P)	4
Loudspeaker connector (16P)	2
Amplifier connector (4P)	2
AVC connector (8P)	2
DC power wiring terminal (4P)	1
Twist-pair cable (2 m)	1
Audio cable	1
AC power cable	1
Fuse (2A)	1
Product Instructions	1
CD-ROM	1

For more information,
https://honeywellbuildings.in
Call: 1-800-103-0339
Email: HBT-Indiabuildings@honeywell.com

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X-DCS2000/EN
DIGITAL INTEGRATED SYSTEM MANAGER

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POLYCAB

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Document ID: TE/QMS/F/02
Rev. No. : 00 Issued Date : 02/04/2018

Technical Datasheet of FAS Cable

	CB CODE	LVBS09CXSWYL002C1.5SA007S
S.No	**Particulars**	**2 X 1.5**
1	Name of Manufacturer	Polycab India Ltd.
2	Type of cable	2XWY
3	Voltage Grade V	1100
4	No of cores X size in sqmm	2 X 1.5
5	**Conductor**	
a)	Material	Plain annealed Copper as per Class 2 of IS: 8130, latest
b)	Max. d.c. resistance of conductor at 20° C (ohm/km)	12.10
c)	Shape of the conductor	Stranded Circular
6	**Insulation**	
a)	Material	XLPE as per IS 7098(Pt-1)/88, Latest
b)	Minimum thickness (mm)	**0.44**
c)	Core Identification	Red, Black
7	**Inner Sheath**	
a)	Material	Extruded PVC Type ST2 as per IS: 5831/84
b)	Minimum thickness (mm)	**0.3**
8	**Armouring**	
a)	Material	Galvanised Steel
b)	Type of armouring	Round Wire
c)	Nominal size of armour (mm)	**0.9**
d)	Tolerance	± 0.030 mm
9	**Outer Sheath**	
a)	Material	Extruded FR-LSH PVC Type ST2 as per IS: 5831/84
b)	Thickness (mm)	1.24 (Min.)
c)	Colour of outer sheath	Red
10	**FR-LSH PROPERTIES**	
a)	Oxygen Index	Min. 29% as per ASTM D- 2863
b)	Temperature Index	Min. 250 Deg.C as per ASTM D- 2863
c)	Smoke Density Rating	Max. 60% as per ASTM D- 2843
d)	Acid Gas Generation	Max. 20% as per IEC- 754- 1
11	**Electrical Parameters**	
a)	Max. a.c. resistance of conductor at 90° C (ohm/km)	15.4
b)	Calculated Cable reactance (ohm/km)	0.105
c)	Impedance of cable (ohm/km)	15.4
d	Approx. Cable Capacitance (mfd/km)	0.18
12	Maximum conductor temperature under normal operating conditions	90°C
13	Maximum conductor temperature at the termination of short circuit	250°C
14	Short Circuit rating of conductor for the duration of 1 sec (kA)	0.21
15	**Continuous Current carrying capacities**	
(a)	In Ground at 30°C (A)	31
(b)	In Air at 40°C (A)	27
16	Applicable Standard	Generally as per IS 7098 Part I/88, IS 8130/2013, IS 5831/84, IS 3975/88 etc. with latest up to date amendments
17	Overall diameter of the cable in mm	11.5 ± 2.0
18	Minimum bending radius	12 times Overall diameter
19	**Max. Tensile strength**	
(i)	for Cables pulled with stocking (Newtons)	9 x D^2, D is the cable OD in mm
(ii)	for Cables pulled with pulling eyes (N)	150
20	**Printing**	**YEAR POLYCAB ELECTRIC 1100 VOLTS GRADE XLPE FR-LSH, 2 CORE X 1.5 SQ.MM CABLE TYPE "FIRE ALARM CABLE" Sequential length marking at every one meter interval**
21	Standard Drum Length (Mtr.)	1000 ± 5%
22	Non-Standard Drum Length (Mtr.)	Maximum 5% of order quantity

Note:-The values given above are subject to tolerances as per the relevant standards